17/2

FEDERATION OF NIGERIA

Annual Report on the Department of Agricultural Research

for the year 1957-58

NINEPENCE NET

RAM

1959

LAGOS: FEDERAL GOVERNMENT PRINTER

COMMONWEALTH MYCOLOGICAL INSTITUTE
30 JUL 1959

FOREWORD

Most thinking people must be aware of the importance of agricultural research to the economic prosperity of our country, and it is undoubtedly a fact that unless Nigeria can expand its agricultural production to feed the rapidly increasing population, its economic development as an independent nation will be severely retarded.

It is to meet this need that the work of the Department of Agricultural Research is devoted amongst other things, to the development of high-yielding varieties of food crops, the maintenance of soil fertility, and the control of pests and diseases which attack the crops so vital to the country's well-being.

The Department, hampered though it has been by an acute shortage of staff, has done valuable work during the past year. But if we are to carry out a research programme on the scale dictated by the country's needs, it is essential that we find ways of attracting qualified staff to our service now. For the future we look to our young people now in training to strengthen the Department, and I sincerely hope that many more, appreciating the importance of this work, will come forward to make their contributions to our country's progress.

V. MUKETE, M.H.R.
Minister of Research and Information

CONTENTS

	Page
Staff List	5
Report by the Director	7
Divisional Reports :	
Chemistry and Soils	14
Botany	17
Rice Research	21
Entomology	27
Plant Pathology	35
West African Maize Research Scheme	37
Publications	38
Appendices :	
Tables 1-7	39
Organisation Chart	43

Staff List as at 31st March, 1958 (including the West African Maize Research Scheme

Directorate

Director of Agricultural Research :

J. M. Waterston, B.SC., PH.D. (Edin.), F.L.S., A.I.C.T.A.

Deputy Director :

Vacant

Administration Division

Scientific Staff :

C. M. Petrie, M.A. (St. Andrews), PH.D. (Edin.)

Higher Technical Staff :

W. A. Porter, N.D.A., C.D.A.
E. O. Ekpenyong . . . . . } In training
J. C. Ezenwa . . . . . } In training
S. C. O. Nwinyi . . . . . } In training
7 vacancies

Executive Staff :

M. I. Ntephe
2 vacancies

Botany Division

Scientific Staff :

B. D. A. Beck, B.SC., (Manc.), D.A.S. (Cantab.), D.T.A. (Trinidad)
A. W. Waitt, B.SC. (Edin.), D.A.S. (Cantab.), D.T.A. (Trinidad)
7 vacancies

Higher Technical Staff :

A. O. Bamtefa
Miss L. J. Cookey
M. J. Ekandem
E. V. Inyang

Chemistry Division

Scientific Staff :

Mrs T. C. N. Baker, B.SC. (Lond.)
J. A. R. Bates, B.SC. (Wales), A.R.I.C.
5 vacancies

Entomology Division

Senior Entomologist :

F. A. Squire, B.SC. (Rhodes, S.A.), A.I.C.T.A.

Scientific Staff :

J. L. Gregory, B.SC. (Sheffield), D.A.S. (Cantab.), D.T.A. (Trinidad)
K. M. Harris, B.SC. (Wales), D.A.S. (Cantab.), D.T.A. (Trinidad)
1 vacancy

Higher Technical Staff :

F. O. Iwenjora

Plant Pathology Division

Scientific Staff :

S. R. Chant, B.SC., PH.D. (Edin.), D.A.S. (Cantab.), D.T.A. (Trinidad)
4 vacancies

Higher Technical Staff :

S. G. Jackson, Hort. Cert. Edin.
J. A. Marden, Dip. Hort. (Wisley), Kew Cert.
E. D. Oddy, Dip. Hort. (Wisley)
S. O. Olubode (on study leave)
J. K. Olurin

Rice Research Division

Scientific Staff :

J. K. C. Dunlop, B.SC. (Glasgow), A.R.T.C., A.R.I.C., D.A.S. (Cantab.), D.T.A. (Trinidad)
J. E. Y. Hardcastle, B.SC. (Dunelm.), D.A.S. (Cantab.), D.T.A. (Trinidad)
G. Jenkins, B.SC. (Wales), D.T.A. (Trinidad)
4 vacancies

West African Maize Research Unit

Scientific Staff :

R. H. Cammack, B.SC., PH.D. (St. Andrews)
C. L. M. van Eijnatten, l.i. (Wageningen)
1 vacancy

Higher Technical Staff :

Mrs G. Offiong
A. A. Ononokpono

Research Fellowship

Name	*Place of Tenure*	*Subject*
C. N. Williams, B.SC. (Natal) ..	University College, Ibadan	Striga Investigations

Members of the Scientific Staff who left between April 1957 and March 1958

Entomology Division :

G. S. Cotterell, A.R.C.S. (Lond.), D.F.C., F.R.E.S.

West African Maize Research Scheme :

W. R. Stanton, B.SC. (Reading), PH.D. (Lond.)

Annual Report on the Department of Agricultural Research, Federation of Nigeria, for the year 1957-58

REPORT OF THE DIRECTOR

INTRODUCTION

There were no major changes in policy as outlined in the Annual Report for 1955-56 during the period under review. The main lines of investigation followed those of the previous year and included studies on the factors affecting soil fertility, together with the improvement of food crops and the control of plant diseases and pests. Details will be found under the appropriate divisional headings which follow this report.

The extreme shortage of scientific staff in Nigeria continues to be a most serious problem. The number of senior staff vacancies (superscale, administrative and professional grades) is higher in the Department of Agricultural Research (70%) than in any other Federal Department. Comparative figures are as follows : Fisheries Research 67% ; Forestry Research 47% ; Veterinary Research 43% ; Civil Aviation 32% ; Posts and Telegraphs 31% ; Geological Survey 27% ; Meteorological 26% ; and Public Works 23%. It will be observed that the Departments in the Ministry of Research and Information are among the most understaffed. This is a matter for serious concern in a country whose economy is based very largerly on agriculture and whose future progress will be intimately associated with the rate of development of her natural resources. It is here that scientists can play a fundamental part in devising enduring agricultural systems aimed at a more intensive use of the land as well as a higher technical efficiency in the production of both food crops and export crops. Provision has been made in the Economic Programme towards these ends, but it is obvious in the light of the present situation that drastic measures for the improvement of the recruitment of scientific staff are indicated if the expansion of research envisaged is to be implemented.

It is to be hoped that the steps taken by Government in the provision of scholarships and the Emergency Science Training Scheme will alleviate the situation in a few years' time. At present, a total of 24 of the Junior Staff have been selected for training for higher posts. Their absence from the Department has placed an extra burden of responsibility on the remainder of the technical staff, and this opportunity is taken to express appreciation of their loyal devotion to duty under difficult working conditons.

ORGANISATION

Financial assistance from the Colonial Development and Welfare Fund for rice research terminated in 1957, and Scheme R514 was incorporated in an expanded Rice Research Division as part of the Economic Programme. In addition to this Crop Division, the Department was organised for administrative convenience into an Administration Division and four Science Divisions (*see* Organisation Chart). Staff from the Science Divisions work as members of a team on approved research projects, whilst others are available for attachment to regional research stations.

During the period under review, a Food Crop team composed of two Plant Breeders, one Plant Pathologist and one Entomologist was engaged on the improvement of cassava, yams and sweet potatoes, whilst an additional Entomologist was attached to Samaru in the Northern Region to study problems of pest control in cereals. Another team consisting of two Plant Breeders and one Chemist was engaged on the improvement of rice.

Grants borne on the Department's vote were made to the University College, Ibadan, for two research fellowships ; one to undertake investigations on witchweed (*Striga* spp.), and the other for a study of the ecology of weaver birds, (*Quelea* spp.)

STAFF

The Department lost the services of Mr G. S. Cotterell, Senior Entomologist, on retirement, and of Dr W. R. Stanton, Senior Scientific Officer, on transfer from the West African Maize Research Unit to the Northern Region Ministry of Agriculture and Natural Resources. These losses were offset by the recruitment of Mr F. A. Squire, Senior Entomologist, Dr C. N. Petrie, Librarian, and Mrs T. C. N. Baker, Temporary Specialist Officer.

The authorised establishment of specialist research staff was increased from 26 to 46 but the rate of recruitment was very slow as is shown in Table 1 (*see* Appendix), and there were only 15 posts filled with 31 vacancies at the end of the period under review.

The authorised establishment of senior staff at the beginning of the year and the actual strength at 31st March, 1958 are given below. It will be noted that there was a total of 42 vacancies in an establishment of 73.

PROFESSIONAL	*Authorised*	*Actual*
Director of Agricultural Research	1	1
Deputy Director of Agricultural Research	1	—
Principal Research Officers	5	—
Senior Specialists	3	1
Senior Agricultural Officers	1	—
Specialist Officers	28	10
Scientific Officers (Soil Fertility Unit)	2	—
Analyst	1	—
Librarian	1	1
Sub-total Federal Research	43	13
West African Maize Research Unit		
Chief Research Officer	1	—
Scientific Officers	2	2
Total Professional Staff	46	15
HIGHER TECHNICAL		
Technical Officers	4	4
Assistant Technical Officers	14	8
Laboratory Technologists	4	2
Station Managers	2	1
Total Higher Technical Staff	24	15
EXECUTIVE		
Higher Executive Officer	1	—
Executive Officer	1	1
Records Officer	1	—
Total Executive Staff	3	1
Grand Total Senior Staff	73	31

The corresponding position for Junior Staff at 31st March, 1958 showed a total number of 62 vacancies in an establishment of 223, as follows :

	Authorised	*Actual*
CLERICAL		
Secretary-typist	1	1
Chief Clerk	1	1
Assistant Chief Clerks	2	1
First Class Clerks	9	7
Second and Third Class Clerks	27	23
Library Assistant	1	1
Total Clerical Staff	41	34
TECHNICAL		
Senior Agricultural Assistants, Grade II	6	4
Agricultural Assistants, Grade I	9	5
Agricultural Assistants, Grades II and III	61	42
Photographic Assistant, Grade I	1	1
Draughtsman, Grade II	1	—
Total Technical Staff	78	52
MINOR TECHNICAL AND CLERICAL (SCALE F)		
Senior Field Overseers	6	6
Field Overseers, Grades I and II	60	37
Artisans	4	4
Driver Mechanics	5	2
Clerical Assistants	11	11
Total Minor Technical Staff	86	60
SUB-CLERICAL AND MINOR TECHNICAL (SCALE G)		
Laboratory Attendants, Grade II	6	3
Telephone Attendants	3	3
Messengers	9	9
Total Sub-clerical Staff	18	15
Grand Total Junior Staff	223	161

The shortage of senior staff continued to seriously hamper the development of the Department's research programme. With a view to remedying this a special effort was made to select suitable candidates from serving officers in the junior staff grades for further training to fit them for higher posts in the Civil Service. The records of over 40 officers in the Department were scrutinized with a view to selecting outstanding candidates suitable for undertaking the necessary training to equip them for specialist research. As a result a total of 24 members of the Department's junior staff are undergoing this type of training at the present time. Ten are studying at universities on Federal Government Scholarships for Science degrees (five in the United States of America and five at the University College, Ibadan) ; four are undertaking study leave in the United Kingdom and six are participating in the Federal Government's Emergency Science Training Scheme at Lagos. In addition three other members of the junior staff are studying overseas for university degrees and one is on study leave, all on regional government scholarships.

During the review of the 40 serving officers it was discovered that only 15 possessed the minimum qualifications which entitled them to enter a career in science, *i.e.*, School Certificate with credits in English language, elementary mathematics and one subject in the biological sciences. There would thus appear to be a very real need for the setting up of a Vocational Guidance Committee to advise young scholars in the secondary schools on the study of appropriate subjects which are a pre-requisite for scientific careers.

As will be seen below, there are at present 172 Nigerians, 20 expatriates and 104 vacancies in the Department's total establishment of 296.

PROGRESS IN NIGERIANISATION, 1958

Posts	*Nigerian*	*Expatriate* (P)	*Expatriate* (C)	*Vacant*	*Total*
Professional	—	10	5	31	46
Higher Technical	11	—	4	9	24
Executive	1	—	—	2	3
Clerical	33	—	1	7	41
Technical	52	—	—	26	78
Minor Technical	60	—	—	26	86
Sub-clerical	15	—	—	3	18
Total	172	10	10	104	296

(P) = pensionable (C) = on contract terms

PROGRESS OF RESEARCH WORK

Progress of research work was severely hampered not only by shortage of staff but by inadequate facilities. These are at present being shared at Moor Plantation with the Western Region Department of Agriculture. Negotiations were continued with the Western Region Government with a view to the re-apportionment of the area to permit the implementation of the projected expansion of Federal Research facilities which is envisaged in the Economic Programme. In the interim Federal Research is being conducted with improvised facilities.

Investigations on Soil Fertility.—The Chemists continued investigations on the nature and properties of soil organic matter with a view to identifying the organic compounds present which contribute most to soil structure. The ultimate aim of these investigations is to devise agricultural systems for maintaining soil fertility which will replace the traditional forest fallow and avoid the extravagant use of land which shifting cultivation entails.

Improvement of Food Crops.—Good progress was made by the Plant Breeders in the improvement of cassava and some high-yielding, disease-tolerant types have been introduced which are being further studied. Work was also started on the improvement of yams, sweet potatoes and coco-yams.

The sub-station for rice research at Badeggi carried out an extensive range of field trials and promising varieties are being selected to suit local environmental conditions.

Control of Plant Diseases and Pests.—The Plant Pathologists, Entomologists, and Plant Breeders worked as a team on the cassava mosaic problem. A start has been made on the taxonomy of the white-fly vector, *Bemisia tabaci*, and its relationship to the cultivation of tabacco, cassava and cotton is being further studied.

Further work was also carried out on the biology and control of the yam beetle, *Heteroligus meles*. Both 2.5 per cent Aldrin and 5 per cent Chlordane dusts appear promising as treatments for seed yams.

Other entomological work included research on lepidopterous stem-borers of maize, guinea corn and millet, and sorgum midge of guinea corn. Crop residues have been shown to be of outstanding importance in carrying over larvae from one growing season to the next.

The effect of mosaic disease on cassava yields was investigated in detail by the Plant Pathologist, and a start was made on the elucidation of the mosaic virus complex of cowpeas which at present is a limiting factor in legume production over a wide area in Nigeria.

Research Fellowships.—The appointment of a Research Fellow for studies on plant pests (witchweed, *Striga* spp.) was made towards the end of the year. He has already started investigations on the development of agricultural practices designed to rid the soil of the seeds of this parasitic weed. The research fellowship for Quelea bird studies remained unfilled.

AGRICULTURAL TECHNICAL COMMITTEE

The Fourth Meeting of the Agricultural Technical Committee was held at Enugu on 30th April to 2nd May, 1957, and the Fifth Meeting was held at Buea in the Southern Cameroons on 16th and 17th March, 1958.

MEETING OF RESEARCH WORKERS

A botanical conversazione was held at the Headquarters of the Department of Agricultural Research, Moor Plantation, Ibadan, on 12th July, 1957, which was attended by botanists from both Federal and Regional Departments and the University College, Ibadan. A further meeting was held at the University College, Ibadan, on 17th October, 1957, when a Symposium on virus diseases was presented by members of the College and the West African Cocoa Research Institute. Both meetings were well attended and proved stimulating to those taking part.

Mr J. E. Y. Hardcastle represented the Department at the very successful West African Cotton Research Conference which was held at the Northern Region Agricultural Research Station, Samaru, on 17th-23rd November, 1957.

INTER-TERRITORIAL RESEARCH COMMITTEES

Meetings of the Management Committees and Technical Sub-committees of the West African Cocoa Research Institute and the West African Institute for Oil Palm Research were regularly attended and the needs of all regions kept in view. The Nigerian Sub-station of the West African Cocoa Research Institute at Moor Plantation, Ibadan, continued to make good progress with developing methods for the more efficient control of outbreaks of cocoa swollen shoot virus.

COLONIAL DEVELOPMENT AND WELFARE SCHEMES

West African Maize Research Scheme.—Breeding work continued on the production of inbred lines with the ultimate aim of obtaining synthetic maize varieties. Pathological work included further studies on *Puccinia polysora*, and a new virus disease provisionally termed pellucid ring spot.

Nigerian Rice Research Scheme.—Contributions from the C.D. & W. fund ceased and the scheme was absorbed in the Department's Rice Research Division as part of the Economic Programme. A full account of the progress made will be found in the Divisional Report on Rice Research.

DISTINGUISHED VISITORS

The Department was honoured by the following distinguished visitors to its Headquarters at Moor Plantation, Ibadan :—

H.E. Sir James Robertson, G.C.M.G., G.C.V.O., K.B.E., Governor-General of the Federation and Lady Robertson; Lord Reith, P.C., G.C.V.O. G.B.E., G.B., T.O., Chairman, Colonial Development Corporation ; G. W. Nye, C.M.G., O.B.E., Agricultural Adviser to the Secretary of State for the Colonies ; Mr Marvin Klemme, United States Embassy, Monrovia, Liberia ; Mr T. V. Anderson, World Bank ; Mr A. V. Raghavachar, Adviser on Industrial Development to the Western Region Government ; and S. J. E. Southgate, Chief Secretary, West African Inter-Territorial Secretariat.

Visitors to the Federal Rice Research Sub-Station at Badeggi included His Excellency Sir Gawain Bell, K.C., M.G., C.B.E., Governor of the Northern Region and Lady Bell; R. E. Greswell, Resident, Niger Province and D. Rhind, O.B.E., Secretary for Agricultural Research, Colonial Office.

Interchange of Visits by Agricultural Research Specialists to Neighbouring Regions and Territories

Dr J. M. Waterston, Director of Agricultural Research, visited the West African Institute for Oil Palm Research, Benin, on 9th-10th June, on 9th-11th August, 1957, and 10th-13th March, 1958, and the West African Cocoa Research Institute, Tafo, on 13th-16th August, 1957, and 10th-13th February, 1958. He was on tour in the Eastern Region from 26th August-13th September and visited agricultural stations and plantations at Nkwele, Umudike, Nekede, Abak, Calabar, Enugu, Adani, Nsukka and Abakaliki. He also visited Badeggi on 28th May-1st June and on 4th-7th November, 1957, the Southern Cameroons on 15th-20th March, 1958 and Vom and Samaru on 26th January-3rd February, 1958.

Mr J. E. Y. Hardcastle, Botanist-in-Charge of the Federal Rice Research Sub-Station, visited the Eastern Region to advise on the development of rice research in the mangrove swamps of the Niger Delta in June 1957, and also visited Birnin Kebbi and Argungu fadama on 25th September-2nd October for joint discussions with the Principal Agricultural Officer-in-Charge of the West African Rice Research Station, Rokupr, Sierra Leone, in connexion with projected rice research in the Sokoto river fadama.

Mr Hardcastle also visited the Pateggi and Ladi fadamas on 29th-31st October, to inspect the performance of rice varieties, and Kano, Potiskum, Maiduguri, Bauchi, and Jos in connexion with rice variety trials on 24th November-5th December.

Mr G. Jenkins, Botanist, visited Adani, Abakaliki, Umudike, Enugu and Yandev on 9th-21st November on tour of the rice growing areas.

Dr S. R. Chant, Plant Pathologist, visited the Southern Cameroons to investigate coffee diseases from 28th June-7th July.

Mr B. D. A. Beck, Botanist, visited Owena and Ilora on 19th-30th August, Akure and Ondo on 23rd-25th November and Badeggi, Samaru and Vom in March in connexion with cassava trials, and Mr A. W. Waitt, Botanist, visited the Eastern Region on 28th November-8th December in connexion with yam trials.

Mr F. A. Squire, Senior Entomologist, visited Ago-Are and Ogbomosho, during February and March to investigate whitefly infestations on tobacco, and Mr J. L. Gregory, Entomologist, visited Ifon and Okitipupa in connexion with yam beetle work in April, and flew to Kano in May for discussion on locust control. He was stationed at Benin from January until the end of the period under review for field studies on yam beetles. Mr Harris, Entomologist, was stationed at Samaru where he studied sorghum midge and cereal stem-borers.

Dr C. M. Petrie visited the Library of the Northern Region Ministry of Agriculture's Regional Research Station, Samaru, 22nd-28th January, and also Ghana from 21st-28th March to attend a West African Library Association Conference at Achimota, and to see the Library of the West African Cocoa Research Institute, Tafo.

Mr J. A. Marden, Technical Officer, visited Calabar to advise on siting of the Federal Plant Quarantine Station on 14th-20th October, and Mr E. D. Oddy, Technical Officer, visited Burutu on 28th October-4th November in connexion with the inspection of benniseed shipments.

Messrs J. A. Marden and E. D. Oddy visited the West African Cocoa Research Institute, Tafo, Ghana, to study methods employed in cocoa propagation as well as methods for diagnosing virus diseases.

Messrs Barnes and Baker, Agronomists, Western Region, and G. Williams, Agricultural Officer, Northern Region, studied experimental techniques at the Federal Rice Research Station, Badeggi.

Visiting research workers from outside territories included K. Wilson Jones, Colonial Pesticides Research Committee; Dr Jean Risbec, Scientific Secretary, Inter-African Phytosanitary Commission; Professor Alexander Brown, Department of Medicine, University College, Ibadan; Dr H. L. Richardson, Imperial Chemical Industries, London; Professor J. McIlroy, Faculty of Agriculture, University College, Ibadan; P. C. Chambers, Agricultural Adviser, Ministry of Agriculture, Northern Region; T. A. Phillips, Director of Agriculture, Ministry of Agriculture and Natural Resources, Eastern Region; K. S. Hocking, Colonial Pesticides Research Unit, Arusha, Tanganyika; J. Voelcker, C.B.E., Colonial Development Corporation; Dr A. L. Abel, Chesterford Park Research Station, Saffron Walden, Essex; Professor G. H. Ahlgren, Dr M. A. Fennel and Dr F. B. Sands, International Development Services, Inc. New York, U.S.A.; Hassan Mutwakil, Assistant Director of Agriculture, Sudan; A. W. Ireland, Deputy Director, Meteorological Department, Lagos; Professor H. C. de Wit, Laboratory Plant-system, Wagenigen; Dr J. I. Taylor, Director of Federal Veterinary Research, Vom; Dr E. C. Baptist, Director, Rubber Research Institute, Ceylon; and E. J. Jefferies, Director, Federal Institute of Industrial Research, Lagos.

ACKNOWLEDGMENTS

It is a pleasure to record our appreciation of the continued interest and helpful assistance received from the Commonwealth Agricultural Bureaux, and the Rothamsted Experimental Station, East Malling Research Station and the Long Ashton Agricultural and Horticultural Research Station.

J. M. Waterston,
Director of Agricultural Research

15th September, 1958.

DIVISIONAL REPORTS—CHEMISTRY AND SOILS

STAFF

J. A. R. Bates .. .. *Chemist*
Mrs T. C. N. Baker .. .. *Plant Physiologist (Temporary)*

I.—STUDIES ON SOIL ORGANIC MATTER

Investigations continued on the nature and properties of organic matter in tropical soils. Little is yet known of the role of soil organic matter in tropical agriculture. Plant residues added to the soil under tropical conditions are readily decomposed, but the organisms decomposing this dead vegetation do not appear to produce humus in the sense accepted in temperate countries. The present studies are aimed at identifying the types of organic complex present, and obtaining an understanding of the individual and collective parts they play in stabilizing nutrient supplies and improving soil structure.

Laboratory work.—The soil used for most of the preliminary work reported here was a forest soil which may be considered as one of the varieties of the local Ibadan soil type. The sampling site has been under high forest for at least 50 years. The cropped soil used was taken from fields on Moor Plantation which had been cropped continuously for about 30 years, and represents a practically exhausted soil of the same general classification as the forest soil. In all cases the sample taken was from the top 0″-4″, air-dried and passed through a 1 mm. sieve. The comparative figures for carbon and nitrogen in the two soils were :—

	Forest Soil	*Cropped Soil*
Carbon per cent	3.8	0.73
Nitrogen per cent	0.58	0.07

A separation of the forest soil into physical fractions was carried out to determine the amount of soil organic matter still in the form of plant and animal debris and gave the following results :—

Fraction	*Percentage by weight*	*Percentage carbon*
Plant residues	0.1	36.0
Plant residue-silt complex	3.5	27.8
Sand (coarse and fine)	59.7	0.08
*Silt	28.6	8.7
†Clay	4.6	4.7

The sand fractions contribute about 60 per cent to the total weight of the soil, but contain only 2 per cent of the total organic matter, probably as contamination from other fractions. The bulk of the organic matter is attached to the silt-sized particles and some preliminary work was carried out on this fraction. A comparison of the extracting power of sodium hydroxide and sodium fluoride gave the following results :—

	Percentage carbon	*Percentage nitrogen*	*C/N*
Silt fraction	8.4	0.88	9.5
After extraction with NaF	8.0	0.79	10.0
NaF extract	0.4	0.09	4.5
After extraction with NaOH	5.8	0.54	10.8
NaOH extract	2.6	0.34	7.6

Thus fluoride extracts less nitrogen in relation to carbon than does hydroxide which confirms Bremmer's work (J. Agric. Sci. 39 : 280).

* Settling time in water, 5-30 minutes.
† Settling time in water, over 30 minutes.

Treatment with 3 per cent hydrogen peroxide prior to extraction with sodium hydroxide and sodium fluoride showed that the peroxide treatment oxidises material of high C/N ratio, and increases the amounts of organic matter extracted by both sodium fluoride and sodium hydroxide. Even with drastic oxidation treatment, using hot 6 per cent hydrogen peroxide, only 85 to 90 per cent of the total organic matter was oxidised, the remainder being resistant to oxidation and extraction.

Cation exchange data for fractions of the forest and cropped soil emphasise the differences in exchange capacity (milli-equivalents per 100 g) which parallel the differences in organic matter content.

	Forest Soil (3.8% *carbon*)	*Cropped Soil* (0.73% *carbon*)
Plant residue-silt complex	107.2	52.8
Sand	2.3	2.2
Silt	41.0	22.6
Clay	41.2	32.8

A recent and more detailed physical separation divides the soil into nine fractions. The first three are very rich in plant and animal residues and the carbon content is 25-27 per cent. In these fractions, plant and animal fragments are easily identified under the microscope, and intact plant cells have been observed in thin sections suitably prepared. The soil particles between 50 and 200 microns, and 200 and 1,000 microns have been designated fine sand and coarse sand respectively. These contain practically no organic matter and have been discarded. The remaining four fractions, defined in terms of the logarithms of the minimum settling velocity, are shown below :—

Fraction	*Min. log settling velocity*
Coarse Silt	$\bar{2}.50$
Silt	$\bar{4}.92$
Fine Silt	$\bar{4}.54$
Clay	$\bar{4}.54$

It must be emphasised that this fractionation is not a mechanical analysis but a separation into water-stable aggregates of varying sizes. Each fraction is at present being examined with a view to identification of the organic compounds and complexes present.

About 5 per cent of soil organic matter was found to be soluble in hot alcohol/benzene (50 : 50). From this extract, resin acids have been isolated as a brown resinous powder, mp. 88°-93°C. These are diterpene acids in various stages of isomerisation ; in the soil they may be esterified with diterpene alcohols. Both chlorophyll and a member of the xanthophyll series have been detected in the extracts from the plant and animal residues. The soil fractions, after extraction of the fats, have been further extracted with sodium hydroxide and the so-called 'humic' and 'fulvic' fraction separated. Further fractionation of these organic complexes has been started using chromatography and other techniques.

Field work.— A new grass fallow experiment was planted during the rains of 1957. Twenty acres of impoverished land were contoured and five types of grass planted. Those chosen were *Cenchrus ciliaris*, *Eragrostis curvula*, Bambatsi *Panicum*, Giant Star grass, and Guinea grass. Valuable experience was gained in the problems of grass establishment and management. The

grasses are fairly well established but need another season's growth before soil sampling is commenced. The object of this experiment is to make quantitative measurements on the rate at which the various grass fallows increase the level of organic matter and available nutrients in the surface soil.

II.—*Fractionation of Soil Phosphorus*

Normal phosphate fertilizers added to tropical soils are frequently retained by the soil in forms not available to the plant. This fixation of phosphate is often attributed to the presence of free iron and aluminium. Current investigations are directed at obtaining information about the nature of the fixation, and the rate at which the phosphate becomes unavailable.

The samples were taken from the 0"-4" soil layer described in Section I above.

Each was extracted with

(*a*) 0.5N acetic acid

(*b*) Truog's reagent (0.002N sulphuric acid buffered to pH3 with ammonium sulphate)

(*c*) 0.5M sodium bicarbonate (pH 8.5)

(*d*) Hot 0.1N Sodium hydroxide

The phosphorus content of the extracts was determined by the molybdenum blue method using a Hilger 'Spekker' absorptiometer.

The results are shown below :—

Extractant	*Forest Soil*		*Cropped Soil*	
	p.p.m. P extracted	*p.p.m. P extracted by successive extractions on same sample*	*p.p.m. P extracted*	*p.p.m. P extracted by successive extractions on same sample*
Acetic acid	12.3	12.3	4.6	4.6
Truog reagent	12.9	9.9	9.2	5.2
Sodium bicarbonate	10.0	6.0	4.5	3.5
Sodium hydroxide	25.0	19.1	27.3	15.7

These figures suggest that the four extractions used remove different forms of phosphate and indicate that iron and aluminium phosphates (which are extracted by the sodium hydroxide only) predominate. Estimations of iron and aluminium in these soils, as extracted by Morgan's reagent (10 per cent sodium acetate in 3 per cent acetic acid, pH 4.8), give higher values for both iron and aluminium in the cropped soil than in the forest soil.

Soil	*p.p.m. Fe extracted*	*p.p.m. Al extracted*
Forest Soil	0.7	0.4
Cropped Soil	1.1	3.7

The capacity of soils for retaining phosphate and the forms in which it is fixed are being further studied.

BOTANY

STAFF

B. D. A. Beck	*Botanist*
A. W. Waitt	*Botanist*
A. O. Bamtefa	*Technical Officer*
M. J. Ekandem	*Technical Officer*

FOOD CROPS

Cassava (B. D. A. Beck).—The collection and classification of Nigerian cassava varieties was continued. Acquisitions of *Manihot melanobasis* from Suriname and *M. glaziovii* from Puerto-Rico proved highly susceptible to cassava mosaic at Ibadan. The yields of some of the 1955 cassava acquisitions from Ghana and of 1957 acquisitions from Nigeria are quite promising (yielding over 10 tons per acre) and these are now available in sufficient quantity to undergo trial in 1958.

Field trials consisting of a standard 6-variety-6-replication randomised block were carried out at eight centres in the Western Region. These trials were designed to compare the yield of the five best Moor Plantation selections with the best local variety in each area, to examine interactions between variety and locality in the Western Region, and to observe the reaction of the Moor Plantation varieties to local virus strains. Variety 53101 was the highest yielding of the Moor Plantation varieties. At Fashola, Agege and Moor Plantation the yield of 53101 was significantly greater than all other varieties, but not at Ilora, Akure and Ado-Ekiti. At Irrua, 55141 was the highest yielding variety giving a significantly greater yield than the local and 53101, and there was no significant difference between the yield of the local variety and 53101. At Effurun, the local variety was the highest yielding but the difference between the local and 53101 was not significant.

The Moor Plantation and Ado-Ekiti trials gave a significantly greater yield than any of the others. The yields of the trials at Fashola and Effurun were lower than that at Moor Plantation. Fashola in the Guinea savannah area and Effurun in the forest area represent the climatic extremes of this series of trials and it would appear that varieties selected at Moor Plantation are not suitable for the type of extreme conditions these stations represent. Variety 53101, however, gave, on the average over all stations, a significantly greater yield than any other Moor Plantation selection, although its yield did not differ from the local varieties at stations east of Akure.

Cassava Trials on Moor Plantation.—A further trial of 31 varieties was planted at Moor Plantation. The yield of variety 53101 was significantly greater than that of any other variety and gave a yield equivalent to 14.4 tons per acre. The next highest yielding varieties in the trial were 32029, an acquisition from Sierra Leone, and 42080 and 42081, two hybrids from variety 37065. There was no significant difference in yield between these varieties and all gave a yield equivalent of over 10 tons per acre. These varieties will be retained for a further year's trial.

The comparison between the growth habits of different varieties of cassava described in the 1957 Annual Report was further investigated to determine the effect of spacing on varieties of different habit.

The low-branched variety 53101 gave its maximum yield per plot at the widest spacing (3′×6′) while the medium and high-branched varieties gave their maximum yield at the closest spacings (3 ×2′), but the differences were not sufficiently large to be significant. The mean yield per stand and the mean tuber number per stand at wide spacings (3′×4′) and (3′×6′) were greater than at close spacing. Variety 53101 gave a greater yield than the other varieties, and 53101 and 53032 formed a closed canopy at all spacings which effectively prevented weed growth.

Nine progeny trials with families of the 1955 series of hybrids were carried out during 1957 and 28 clones have been selected for further trial. The selections from family 37065.12 mentioned in the 1957 Annual Report again gave a very high yield, equivalent to 19.5 tons per acre. During this year these clones have shown slight symptons of mosaic for the first time. Two selections from family 37065.1 gave a yield of over 21 tons per acre. Both of these clones are susceptible to mosaic disease and became infected in 1956.

Cassava hybridisation.—The hybridisation programme was divided into three parts :—

(*a*) The production of *Manihot glaziovii* x *M. utilissima* interspecies hybrids for selection for mosaic resistance followed by back-crossing to cassava to combine mosaic resistance with high yield.

(*b*) Self-pollination and back-crossing the Amani interspecies hybrids to cassava, to investigate the inheritance of mosaic resistance and combine mosaic resistance with high yield.

(*c*) Interspecies hybridisation within the species *utilissima* to produce high-yielding mosaic-tolerant clones for crossing with the interspecies hybrids, and to investigate the inheritance of variety characters in cassava.

Twenty-thousand controlled pollinations were made during 1957, but the percentage of successful crosses was less than in 1956 because of the low cross compatibility in the interspecies crosses. A total of 4,625 capsules were harvested which gave 11,070 seeds. In the *glaziovii* x *utilissima* crosses one series, variety 53101 x *glaziovii*, gave an average of 36 per cent successful pollinations, but the remainder averaged between 2 per cent to 8 per cent success. The Amani interspecies hybrids gave an average of 36 per cent success when back-crossed to cassava. The interspecies *utilissima* crosses gave an average of 23 per cent success ; the Amani interspecies hybrids were most promising and many have shewn no symptoms of mosaic after 15 months' exposure to natural infection in the field.

The acquisitions based on the *glaziovii* x *utilissima* crosses have given the highest percentage of mosaic-resistant types ; 75 per cent of seedlings from a hybrid in the third back-cross generation to cassava have proved resistant to mosaic to date. As a class the *M. melanobasis* x *utilissima* hybrids were the highest yielding in 1957, but this group gave the lowest percentage of mosaic resistant types. The two highest yielding individual acquisitions however were from *glaziovii* x *utilissima* third back-cross to *utilissima* hybrids which gave a yield of 19.4 and 15.6 lb per stand and both appear to be resistant to mosaic. Only 11 per cent of the 1956 series of *glaziovii* x *utilissima* crosses have remained free from mosaic. In addition to the Amani hybrids, 97 clones have now been selected which have shewn no symptoms of mosaic during the past year.

Observations on cassava mosaic.—A classification of cassava leaf symptoms based on the presence or absence of distortion or constriction of the lamina was evolved and an attempt was made to correlate symptom expression with yield. Additional virus symptoms were recorded which varied from discrete patches of bright yellow chlorosis 1 mm. in diameter to a green vein banding.

Normal mosaic symptoms as well as the new type of chlorosis may occur in the same clone, but no individual plant has yet been found showing both symptoms at the same time. This suggests that the symptoms are caused either by a new strain of virus or a new combination of existing strains. The new symptoms have also been recorded on a ceara x cassava hybrid, which has not previously shewn normal mosaic symptoms and was thought to be immune to mosaic. This may be additional evidence of a different strain of virus being involved.

Yams (A. W. Waitt).—The collection of yam varieties was increased with the co-operation of the Agricultural Officer, Onitsha Province. It is hoped, in the near future, to receive a collection of varieties from Yandev Province. Material is also being introduced from the South East Pacific area. These further additions to the collection plots at Moor Plantation should provide a wider range of variation for the systematic study of varieties.

Trials were set up to compare the yields of some varieties of the four main economic species. Fourteen varieties of white yam, eight of yellow yam, twelve of water yam, and six of trifoliate yam were put under trial. In each case the layout was a randomised block. Twelve varieties of white yam gave significantly higher yields than the local popular variety 'Iyawo'. Theoretical yields of nine tons per acre were obtained. With water yam, theoretical yields of 12 tons per acre were obtained, whilst varieties of trifoliate and yellow yam gave in single cases yields of up to 15 tons.

Investigations were also carried out on the rate of germination of the yam sett and the subsequent growth of the tuber and vine. Setts from heads, middles and bottoms of the tuber were studied separately. Only tentative conclusions can be made owing to the poor germination of the setts which caused a large reduction in the number of samples taken throughout the growing period.

However, the results so far obtained suggest that there is a correlation between vine weight and tuber weight and that heads germinate more rapidly than either middles or bottoms although the final yield from each of those setts may be the same. In July to August roots and vines reach their maximum length and weight. From September until harvest there is a reduction in vine weight and root length with a subsequent increase in tuber weight.

A staking trial was laid down to investigate the economic advantages and yield responses to three different methods of staking white yams (variety 'Iyawo'). Three methods of staking were used :—One stake per stand ; one stake per stand with two stakes tied together ; and one stake per stand with four stakes tied together (the normal staking method).

There were no significant differences in the yields from the three methods of staking. However, the thicker stakes used in the single stake method provided a stronger and more stable support than the ones used in the other two methods, and less labour for restaking was required after high winds. The supply of these thick stakes however is very limited and the consequent cost is high which offsets any advantage which this method may have over other methods.

Preliminary investigations into the germination of the seed of *D. dumetorum* and *D. rotundata* have shown that at harvest the seeds contain a rudimentary embryo and that a period of storage is required to enable this embryo to mature. The period and the conditions under which the seeds are stored may be critical. A period of more than three months is required, and storage of the seed under dry conditions is better than storage either under room conditions or under low temperatures. Seeds of the trifoliate yam gave higher germination percentages than those of white yam.

With a view to determining the most suitable method of planting out seedlings into the field, 200 two-month-old seedlings each of *D. dumetorum* and *D. rotundata* were planted out in June by four different methods—with and without baskets, with and without shade. There was 85 per cent survival of the material planted. Planting in baskets was better than transplanting with soil on roots, especially in seedlings of white yam. Seedlings grown under shade are stronger and larger than those planted without shade.

Final conclusions made after harvesting show that seedlings planted in baskets and provided with shade give higher yields and a higher percentage survival than those planted without shade.

Sweet Potatoes (A. W. Waitt).—Eleven new varieties were received from the Department of Agriculture, Northern Region, bringing the total number in the collection plot to 18. Several other varieties were also received from the Department of Agriculture, Fiji.

Two methods of pruning and training the vines were tried to induce flowering. In the first method, the vines were trained over 3-feet wire netting and pruned to one stem with unlimited lateral growth. In the second method, the vine, on 6-feet wire netting, was pruned to a single stem with subsequent fan-type pruning. This second method was successful in inducing flowering.

Several hundred self and cross pollinations were carried out, which revealed that complete self sterility may be present within a variety and a degree of incompatibility between varieties.

The aims in breeding new varieties of sweet potato are to improve yield ; to breed against pest and diseases especially weevil and virus ; and to produce a wet-type of tuber which is more favoured by the local consumers. A small trial is being laid down to investigate the effects on yield and percentage of ware tubers by spacing and time of harvesting.

Cocoyams.—Further additions to the collection have been made from the Northern and Eastern Regions. Material has also been received from the South East area of the Pacific.

TREE CROPS

Citrus (J. M. Waterston).—Further trials of suitable root-stocks for sweet orange at Ibadan continue to demonstrate the superiority of tangerine. The best rootstock for the Nigerian sweet orange variety Agege I was Cleopatra tangerine which gave 2.7 boxes of fruit per tree at the fifth year from planting. The order of merit in yield of the other root-stocks was Lake Tangelo (2.1), Sierra Leone rough lemon (1.7), Agege I sweet orange and Sampson Tangelo (1.1), Seedling Trinidad sour orange and local (Moor Plantation) sour orange (0.2). There were eight trees in each treatment.

Coffee (B.D.A. Beck).—During 1957 the yields of coffee were very low on all plots in the Moor Plantation collection. The *Coffea canephora* variety Quillou Robusta, was the highest yielding variety in 1957, giving a yield of 1,412 lb fresh cherry per acre, the best individual tree giving a mean yield of 48 lb fresh cherry per year. Heavy infestation with coffee berry borer *Stephanoderes hamperii* was observed on all plots. Crop sanitation was not practised in 1957 in order to allow a study of the amount of natural infestation. It was noted that the incidence of the pest on *Coffea excelsa* was only 20 to 30 per cent of that on the *C. canephora* group.

Twenty-eight trees were selected for vegetative propagation. Selection was based on the mean yield of fresh cherry per tree per year over the past fourteen years.

Kola (B.D.A. Beck).—Individual tree recording was continued in the families of inter-species hybrids of *Cola nitida* on Moor Plantation. Hybrids obtained by crossing together two white nut trees were the lowest yielding group of families, both in mean number of nuts per tree and in mean nut weight. The red nut hybrids derived from crossing pink and red nut parents continued to be the highest yielding group of families of trees in the collection. This group gave a mean yield of 161 nuts per tree during 1957 which was more than five times the combined average yield of the other groups of families in the collection.

A series of self-pollinations and back-crosses to the parent trees has confirmed that white nut trees which originate from either selfing or crossing white nut parents are pure breeding for white nut colour. A similar series of crosses has been performed on pink nut hybrids arising from the crossing or selfing of pink nut parent trees. The hybrids have been self-pollinated and back-crossed to their parent trees and it has been shown that these trees breed true for pink colour of the nut. Another attempt was made to self-pollinate hybrid red nut trees produced by crossing two red nut parents. Four hundred and forty-seven self-pollinations have been carried out on this group and none have been successful, which supports the theory that these trees are self incompatible.

In crosses between hybrid trees further evidence was obtained that cotyledon colour in Cola is controlled by at least two pairs of epistatic genes.

RICE RESEARCH

STAFF

J. E. Y. Hardcastle	*Botanist-in-Charge*
J. K. C. Dunlop	*Chemist*
G. Jenkins	*Plant Breeder*

The activities of this Division are centred at the Federal Rice Research Sub-Station, Badeggi, established in 1953 to facilitate research into rice production under Nigerian conditions. The Sub-Station is being expanded, under the Nigerian Economic Programme for 1955-60, to provide facilities for eight research officers including four plant breeders, two agronomists and a chemist under the direction of a principal research officer. Close liaison is maintained with the West African Rice Research Station at Rokupr, Sierra Leone.

BUILDING PROGRAMME

A further three senior staff quarters were completed as well as a permanent water supply system by the end of the year under review.

EXPERIMENTAL FIELDS

Further progress in the programme of levelling and terracing on the 80-acre site within the Badeggi Irrigation Scheme, necessary to obtain complete control of the irrigation water supply resulted in temporarily increased soil heterogeneity due to the inevitable inclusion of infertil termite-mound sites within the newly created rectangular rice paddies. With the assistance of new equipment obtained during the year further modifications were made to the irrigation arrangements in early 1958 which considerably enhanced the degree of water control obtainable over some 50 acres.

The year's rainfall was abnormal being very heavy in May, July and October and below average in September. Early heavy rain in May brought all mechanical cultivation to an end, including the combine drilling of non-experimental material, but the equable distribution of rain in the succeeding months and the late close of the rains contributed to the general vigour of the crop, both on the Station and in surrounding districts. The Kaduna River reached a record flood height and penetrated part of the protected area of the Edozhigi Irrigation Scheme with consequent damage to the Federal fertilizer field trials sited there.

PLANT BREEDING

Plant breeding at Badeggi has as its main aims the production and release of higher yielding, good quality material for the rice producing areas of Nigeria. Wherever possible, varieties released will be confined to one grain type within an ecological zone or well defined area of production in order to maintain and improve milling quality.

In the absence of laboratory facilities the research activity consisted mainly of field experimentation and observation. There were fifteen inter-and intra-varietal field trials laid down, including the series of four inter-varietal trials and seven intra-varietal trials commenced in 1956. The former series were replicated at a number of sites in the three Regions, in some cases for the second successive year, and results generally bear out the conclusions reached in 1956. Owing to the alterations in the layout of the fields at the sub-station a temporary but marked increase in experimental error occurred in most of the trials.

Attempted Hybridisation between Selected Varieties of Oryza glabberrima and O. sativa.—The aim of this programme was to produce inter-species hybrids combining the floating habit and flood resistance of the indigenous species with the superior grain characters of *O. sativa*, *viz*, white caryopsis, better milling quality and non-shattering habit.

Varieties were chosen in pairs for hybridisation according to the available data for life-periods. However, the sowings were made later in the season than normal and although the successive sowings were overlapped, the photoperiodic reaction of the *O.glaberrima* varieties was so marked that the flowering periods of the proposed parents did not coincide. Other varieties of *O. sativa* flowering at the appropriate time were consequently used. The hybridisation technique employed consisted of opening the spikelets with hot air at 43° C in a thermos flask and using forceps for emasculation.

The percentage seed set was very low and a total of only 30 seeds was obtained from five crosses—Kaushi × Toma 112 ; Dan Kashin Shanu × Bolo 108 ; Dan Kashin Shanu × Ngasein 57 ; Dan Kashin Shanu × Faya ; Kauchi × Kalimodu 60. The seeds were sown in moist soil in pots but all failed to germinate. Even allowing for deficiencies of technique, an appreciable degree of inter-species sterility seems likely.

A further complicating factor is that the varieties of *O. glaberrima* used as parents have a dormancy period of 3-4 months after harvest. If this character behaves as a dominant in the F_1 then the raising of hybrid progeny between normal planting seasons would seem to be precluded unless the dormancy is artificially broken.

Introduction and Evaluation of Promising Varieties of O. sativa.—Trial EA 1 (57) of late (7 months) floating varieties gave the following result at Badeggi :—

Mbag Boli ; Indo-China 53 > Bisbais ; MLY-C-407 (P=0.001%)
Mbag Boli > Indo-China 53 (P=0.05%)

The trial was rapidly submerged twice during the growing season and the results indicate that MLY-C-407 and Bisbais, though tolerant of fairly deep water, would not be suitable for areas with a rapidly rising flood. Mbag Boli gave a yield of 12 cwt per acre which was low but reasonable under these conditions and compared favourably with 10 cwt for Indo-China 53.

The result of trial EA 2 (57) of non-floating deep water varieties of similar duration can be summarised as follows :—

PTB—16 > Kontor ; Anak Didek ; Radin China 4 (P=0.05%)
HM—C—17 > Kontor ; Anak Didek ; (P=0.05%)

This trial was also submerged twice during the growing season, a factor which probably contributed to the high coefficient of variation, 43%, which was obtained. PTB—16 gave 7.4 cwt per acre which indicates its unsuitability in rapid flood conditions.

A series of varieties was also planted in observation plots at Birnin Kebbi in Sokoto Province. Three sites were chosen where the depth of water was anticipated as being shallow (< 30″), medium (< 48″) and deep (> 48″) respectively. Results from the shallow site confirmed the belief that *O. sativa* varieties could be grown in the uncontrolled flood conditions of the Sokoto river fadama in those parts where the flood does not exceed 30″.

Although results from the medium and deep flooding sites were inconclusive, because the varieties were planted late and were not sufficiently well established before the arrival of the flood, the performance of the varieties generally confirmed the results from Badeggi. Thus, Kontor, Radin China 4 and Anak Didek all failed, while Mbag Boli, Indo-China 53, PTB-16, HM-C-17 and MLY-C-107 all gave some promise of success under deeply flooding conditions.

Introduction and Evaluation of Promising Varieties and Selections of O. sativa Suitable for Hand Cultivation.—In a trial of late (7 months) deep water varieties Kav 12 gave a significantly greater yield (24 cwt/acre) than Indo-China 53 (19 cwt/acre) and India pa-lil. It is generally evident that India pa-lil is inferior to Kav 12 in the Badeggi area, and this latter variety is now being multiplied to satisfy the demand for a 7-month variety.

There were no significant differences between the yields (25-23 cwt/acre) of Bolo 108, Ngasein 57, Toma 112 and Toma 55 in a trial of 6-month varieties. Replacement of Ngasein 57 by the locally popular Toma 112 is recommended to meet the demand for a 6-month variety tolerant of flood depths of up to 48″. Toma 112 has a C type grain but one more akin to the popular BG 79 shape than Ngasein 57. Bolo 108 will be reserved pending an examination of the milling quality of its B type grain.

The trials which compared W.A.R.R.S. selections of India pa-lil and Ngasein respectively with the parent material failed (for the second year in the case of India pa-lil) to show any significant differences in yield.

In the absence of other decisive characters, it has been decided to adopt the selection India pa-lil 82 (7 months) since it has given the highest yield in both seasons. This selection will be put in trial in the Eastern Region mangrove swamps in due course since it has been proved a successful variety under similar conditions in Sierra Leone.

Ngasein 57 gave a significantly higher yield than the other Ngasein selections. Field observations support the superiority of Ngasein 57 at Badeggi and it has been decided to adopt this selection for any multiplication requirements although its inferior cooking quality has reduced its popularity in some areas.

The results of a two-years' trial of 5½-month varieties at Shendam indicate that higher yields could be obtained by growing D99 (B type grain) or even D 52/37 (A type grain) instead of GEB 24 (small B type grain) which is the principal variety in the area at present. A definite recommendation is reserved pending an examination of the milling quality of these varieties. There is a well established preference for the cooking quality of GEB 24 in this area.

In 1956 a trial of 5-month varieties (including BG 79, the universally popular main crop variety) was laid down at Badeggi, at Lowlands Experimental Farm, Shendam and at Katsina Ala in Benue Province. The trial was repeated at these sites in 1957 and further replications were obtained at Zonkwa (Zaria) Yola, Jere Bowl (Maiduguri) and from the results obtained at these different centres, in some cases over two seasons, the following tentative conclusions can be drawn :—

(*i*) The varieties Mas, D 114 and D 52/37 may be expected to produce substantially higher yields than the two strains of BG (the present standard variety) and Guiana Creole.

(*ii*) The strain BG 79 *ex* Sierra Leone is generally inferior to BG 79 *ex* British Guiana.

(*iii*) Under conditions where controlled irrigation can extend the cropping season beyond the end of the rains, or where, under natural conditions, the normal seeding time would not be later than early May, Mas may reasonably be recommended as the best yielding variety. Where these conditions do not apply it would be preferable to grow D 114 or D 52/37 in place of BG 79.

The reason for the latter conclusion is that Mas has been found to be insensitive to day length whereas all the other varieties in the trial show photoperiodic sensitivity. Consequently, although when sown in late April at Badeggi Mas behaves as a five-month duration variety, it has approximately the same duration when planted late in the season when those of the other varieties is appreciably shortened. It is, therefore, relatively longer maturing when planted late.

On the basis of these results it has been decided to drop Guiana Creole and BG 79 (*ex* Sierra Leone from this trial. A modified version of the trial, retaining BG 79 (*ex* British Guiana) as the standard variety and including Mas, D 114 and D 52/37 will be laid down in 1958 in order to finalise the conclusions reached so far. Later introductions will be included also to find superior yielding varieties to Mas, D 114 and D 52/37.

To cater for the requirements of the upland rice areas a comparative yield trial of upland varieties was laid down as an 8×8 Latin square with very small plots (1/200 acre). It was found that Trinidad Hill rice and Atebubu gave a significant greater yield than the two types of Agbede, Upland (local), Upland (Bikom) and Oshodi. Hill rice also gave a significantly greater yield than Atebubu. The trial was transplanted at the standard spacing of 1 foot×1 foot, and it is possible that this does not favour the low tillering habits of the local upland varieties so that the results obtained do not represent a fair comparison.

In view of the difficulty of simulating true upland conditions at Badeggi, the trial will be undertaken at two sites in the Western Region and at one in Benue in 1958.

Introduction of Varieties Superior to BG 79 for Tidal Freshwater Mangrove Swamp Conditions.—A trial at Calabar which included GEB 24, D 99, Lead, Sughandi, BG 79, AIG and Ceylon, failed to reveal any significant differences between the varieties. Heavy damage to seedlings by crabs and fish and flooding of some plots were reported.

Selections.—A total of 45 F.R.R.S. selections from standard varieties considered suitable for riverain zones is being carried to the field trial stage in 1958.

Summary.—The interim conclusion previously drawn from the first year's observations on the series of four inter-varietal trials in 1956, namely that five varieties would suffice for the main cropping area, have largely been substantiated by the 1957 trials.

The Varietal Collection.—On the advice of Mr D. Rhind, the nursery period of six weeks adopted in 1956 was reduced to four weeks in the year under review. The object of this change was to reduce the disturbance to the tillering phase. The collection was sown on the same dates, *i.e.*, 23rd-25th April and this procedure is to be standardised in future seasons. Reduction of the nursery period shortened the life periods of the early varieties (*i.e.*, those with duration of 140 days or less) in comparison with the 1956 records by 2-3 weeks on average. Varieties of medium and late duration were not noticeably affected.

Two hundred and seventeen varieties were planted at the normal time and a further 26 new varieties were introduced later in the year. The latter included eight upland, six late floating and four early varieties from West African Rice Research Station, Rokupr. During the year W.A.R.R.S. Rokupr was requested to obtain a further 28 flood-resistant, 15 lodging resistant and 9 drought-resistant genetic stocks listed in the F.A.O. catalogue. A total of 58 varieties were rejected from the collection at the end of the year. These consisted of unpromising varieties or duplicated material formerly maintained under synonyms.

The 1957 collection contained 33 local varieties of *Oryza glaberrima* isolated from field collections and now grown in a relatively pure state. These have been classified according to the main taxonomic groups distinguished at present and further sub-divided on the basis of colour characters of the vegetative and floral parts and on physiological characters such as duration and straw height. The 33 varieties fall into 20 groups, as follows :—

Oryza glaberrima Steud. sub. sp. *vera* Chev. 15 groups

O. glaberrima Steud sub. sp. *confusa* Chev. 4 groups

O. glaberrima Steud sub. sp. *stapfii* Roschev 1 group

Investigation of the Photo-periodic Sensitivity of Twelve Varieties of Varied Origin.—The varieties under observation were Mas (*ex*-Indonesia), MYA-B-103, HM-A-9, MLY-C-407 and Ngasein (Burma) ; Biyan A2 and Farin Iri (Nigeria) ; GEB 24 and Kav 12 (India) ; D114 and BG 79 (British Guiana) and Toma 55 (Sierra Leone).

Successive plantings of all twelve varieties were made at intervals of two weeks, commencing on the 29th of April, which is the normal sowing date for the varietal collections at Badeggi, and ending on the 1st November. Badeggi is situated on latitude 9° N where the day length increases gradually from January to June and decreases gradually from July to December, the maximum difference being approximately one hour over the twelve months. The effect of changing length of day was studied in relation to life period, tiller height, tiller number, panicle length and yield (of unreplicated plots) after a nursery period of four weeks. The graph of life period plotted against time of planting shows that the change in life period caused by different planting dates is so slight in Mas and MYA-B 103 that these varieties may be considered time fixed, *i.e.*, insensitive to photoperiod, for all practical purposes. The other ten varieties are photoperiod sentitive and show a reduced life period with progressively later planting until a point is reached where the life period begins to increase again as the photo-sensitive phase of the plant comes under the influence of increasing day length. For the varieties under observation this point was at early to mid-October. The local variety of *O. glaberrima*, Farin Iri, which exhibited the most marked photoperiodic reaction, did not follow this general pattern and the graph of life period was still dropping with the last sowing on 1st November.

The lowest value for life period recorded for Farin Iri represented a decrease of 60% from the normal (*i.e.*, April-sown) duration. In the other nine photoperiod-sensititive varieties the proportional maximum difference in life periods was remarkably similar, being 30-40% irrespective of the normal duration of the different varieties, which ranged from 131 days (Biyan A2) to 233 days (Kav 12).

Of the other factors, panicle length was the most constant under the influence of decreasing photoperiod. However, in the two local varieties of *O. glaberrima* a pronounced decrease in panicle length was evident in the later plantings.

Comparison of Growth rates of O. glaberrima and O. sativa.—It is generally held that the superior adaptation to conditions of deep and swift flooding in the Northern fadamas exhibited by the indigenous varieties of *O. glaberrima* is due to a higher growth rate in the early stages than is the case with exotics. To test this, ten varieties each of *O. glaberrima* and *O. sativa* were selected for observation and paired according to similarity of life period for comparison. Weekly observations on plant height, tiller number and leaf number were taken. Most of the varietal pairs of the *O. glaberrima* varieties showed a slightly higher growth rate in plant height in the early stages but there were no very marked differences in this respect. In the majority of cases the varieties of *O. glaberrima* had a higher rate of tiller production and in nearly all cases showed an appreciably higher rate of leaf production than did the *O. sativa* varieties.

In general, it would seem that the varieties of *O. glaberrima* need the stimulus of a rising water level to show the rapid growth which they are known to possess under flooding.

SEED MULTIPLICATION

The year saw the inception of a nation wide system of rice seed multiplication. As originally envisaged the scheme would produce seed for 150,000 acres annually, approximately half the annual seed requirement of the country. In 1957 the Northern Region Seed Multiplication Centre at Bida was supplied with sufficient pure seed to establish Stage 2 (5-acre) multiplication blocks of the standard varieties including BG 79, GEB 24, Toma 112, Ngasein 57, Indo-China 53 and Kav 12. The harvested seed of this material will be entered into Stage 3 (10-20 acres) multiplication blocks in Northern Region centres in 1958. At the end of the season it proved possible to supply pure seed of BG 79 to establish simultaneously Stage 2 and 3 multiplication centres in the Eastern and Western Regions, while the Northern Region was supplied with improved nuclear stocks for the Stage 2 centre at Bida including BG 79, GEB 24/37, Toma 112 and Kav 12.

AGRONOMY

Two assessment trials of cultural methods commenced in 1956 were repeated and the seed dressings trial laid down in 1956 was also repeated in modified form.

The results of the effect of spacing and stand population on the yield of transplanted rice substantiated the results of the previous year. The 9″ x 9″ spacing produced a significantly greater yield than that from the 15″ x 15″ spacing treatment. The number of plants per stand (2, 6 and 10) had no effect upon yield either directly or by interaction with the spacing treatment.

It is evident that the plant population was considerably greater at the 9″ x 9″ spacing than at the spacing of 15″ x 15″ (ratio 2.76 : 1). There was, however, a significant increase in the number of tillers per stand at the wider spacing which resulted in a reduction in the population disparity between the two treatments. Expressed as "tillers per acre" the ratio of the treatment population (9″ x 9″ : 15″ x 15″) was 1.8 :1. This ratio exceeded that of the "yield per acre" figures indicating a relative increase in panicle weight of nearly 33 per cent at the wider spacing. This aspect is to be investigated further.

A trial designed to show the effect upon yield of separate and combined fungicidal and insecticidal dressings (Mergamma, Agrosan and Gamma BHC) failed to reveal significant differences between the treatments, or between these and the control. No symptoms of fungal insect attack were observed either in the experiment or elsewhere in the surrounding district. Since the Northern Region has discontinued the use of organo-mercurial dressings for cereals this experiment will be replaced by a trial of non-mercurial dressings in 1958.

A number of trials and observations were laid down in the Northern Region in 1957 to compare the yield response of rice to different planting techniques. Few valid conclusions could be drawn from these experiments, repeated at Yandev, Shendam, Zonkwa, Hadejia, Maiduguri and Kwarre, since it was by no means certain that the optimum seed rate, spacing or fertilizer application were used in each treatment. It was however evident that transplanting was unsuitable for most of these Northern centres in the absence of water control and there was some evidence that direct placement of seed gave a better initial establishment than broadcasting under some natural rain-fed conditions.

CHEMISTRY

Construction of the chemistry laboratory was not begun during the year although complete building plans, room plans and chemical indents were submitted, and in the interim the Chemist was based at Departmental Headquarters, Ibadan.

Research was restricted to the soils of the Edozhigi and Badeggi Irrigation Schemes which were provisionally mapped in 1953-54 by Dr H. Vine, then Senior Chemist. Within these limits a detailed examination, chemical, physical and agronomical, of rice soils was commenced.

Physical Analysis of Soils.—The distribution of particle size in the profile of several Badeggi and Edozhigi soil types was completed and was plotted on a percentage clay, silt and sand basis using trilinear co-ordinates. Tables showing the percentage distribution of the various fractions within the profile and graphs of the distribution were prepared. The results should be of interest in soil/water relationship studies, in particular where there is a tendency of soils to flooding and drying out.

Fertilizer Trials.—Several fertilizer experiments were laid down in the field on the major soil series at Edozhigi where water control can normally be achieved, and the response of rice to a wide range of N and P was tested. Three of the experiments, all replications of EA 4 (57) on the Gbajigi, Edozhigi (peaty version) and Mawogi series, were started in 1957, while that on the Edozhigi series EA 12 (56) 57 was in its second year. The rates of application for the EA4 (57) on the Gbajigi, Edozhigi (peaty version) and Mawogi series were deliberately high and in the order of 0.3 and 6 cwt of ammonium sulphate and of superphosphate per acre. This wide range of applications was used to find the point at which response to fertilizer falls off. On the Edozhigi series the rates of application on EA 12 (56) 57 were not so high being of the order of 0.2 and 4 cwt of ammonium sulphate and of superphosphate per acre.

In 1956 in EA 12 (56) ammonium sulphate at both levels (4 and 2 cwt/acre) gave significant increases over the control. There were no responses to similar dressings of phosphate.

Regional Rice Fertilizer Trials.—The results of the standard N.P.K. and NP trials with rice laid down in the Northern Region by the Regional Agronomist in 1957 did not permit of any general conclusions to be drawn. As in 1956 all were carried out on alluvial soils, and, with one exception, without water control.

No significant responses were observed at Maigana, Dutse, Lafia, Utur and Zonkwa. Upland rice at Dongo in Benue Province showed responses to light dressings of both ammonium sulphate and superphosphate. Irrigated rice at Kwarre, in Sokoto Province, showed responses to superphosphate only this year.

The trials were marked by considerable variation in the time of application of the fertilizer and both ammonium sulphate and superphosphate were generally applied, where scheduled, as a combined dressing. The application of superphosphate, either singly or as a combined dressing after seeding or transplanting, can give rise to a prolific growth of algae, reported to be detrimental to the uptake of nitrogen.

ENTOMOLOGY

STAFF

F. A. Squire	*Senior Entomologist*
J. L. Gregory	*Entomologist*
K. M. Harris	*Entomologist*
F. O. Iwenjora	*Laboratory Technologist*

DESERT LOCUST

Locust activity in Nigeria consisted of 52 swarms reported between April and July 1957. No incidence was reported in any part of Nigeria between 31st July, 1957 and 31st March, 1958.

STUDIES ON WHITEFLY

Introduction (F. A. Squire).—The Whitefly, *Bemisia tabaci* (Gennadius); Aleyrodidae, a well-known vector of virus diseases of the leaf-curl and mosaic types is widely distributed in Nigeria and is of considerable importance in connection with the cultivation of tobacco, cassava and cotton.

There has in the past been a good deal of doubt and even confusion over the identity of the species of *Bemisia* concerned with the transmission of plant virus diseases of the leaf-curl and mosaic types in various parts of the world. The insect now known as *Bemisia tabaci* was described by Gennadius in 1889 as *Aleurodes tabaci*. In 1936 it was removed to the genus *Bemisia* by Takahashi and became *Bemisia tabaci* (Gennadius). Since its first description this insect has been described by various authors under no fewer than twelve different names all of which are now believed by taxonomists of this group to be synonymous with *B. tabaci*. The following synonyms closely concern us in Nigeria in particular and in Africa generally:—*Bemisia goldingi* Corbett: *B. nigeriensis* Mistra and Lambda, *B. gossypiperda* Mistra and Lambda and *B. rhodesiaensis* Corbett.

The main southern flue-cured tobacco producing areas centred round Ago-Are in the Oyo Province of the Western Region were visited during February 1958. At the time a severe harmattan prevailed and conditions were generally unfavourable to insect life. But in the riverain fringing forests where there was a more benign micro-climate, *Bemisia* was seen in fair numbers on *Alchornia* sp. (*Euphorbiaceae*). Since the tobacco nurseries are generally sited near streams to facilitate irrigation, the young tobacco plants are liable to be infested at an early age. Moreover, it is on the low lying soils bordering streams that the farmers grow their patches of tobacco during the off-season of the main tobacco crop. These plots, sometimes as much as a quarter of an acre in extent, often harbour aged ratoons heavily infected with leaf-curl virus disease which is transmitted by *Bemisia*.

Thus, from the outset, young tobacco plants in the nurseries are predisposed to attack, and early infection of the crop before it is planted out occurs as is to be expected.

Probably the most important host plant of *Bemisia* is cassava, a crop which has the distinction of being both perennial and almost ubiquitous. The degree to which *Bemisia* has adapted itself to the growth habits of cassava suggests a long and intimate association. The eggs are laid in great numbers on young leaves near the growing tip of the plant. By the time they hatch the leaf has expanded thus affording ample food and shelter for the larvae and later pupae. At the same time the adults (mostly females) congregate and feed on the new leaves.

Another important host-plant of *Bemisia* is cotton. It is widely cultivated in the tobacco producing areas and late cotton picking goes on well into the tobacco planting season.

Thus the three main cultivated host-plants of *Bemisia* are closely associated. To what extent *Bemisia* actually migrates from one to the other remains to be determined. In greenhouse experiments no difficulty has been met in effecting such transference but the question of population movements in the field is under investigation.

Observations on *Bemisia* pupae collected from cassava in the field showed a remarkable disparity in sex. Thus in ten samples together totalling 3,177 pupae, 413 gave rise to male adults and 1,193 to females, a male/female ratio of 0.346. In the separate samples the M/F ranged from 0.254 to 0.419 with mean 0.343 $\pm$ 0.059.

The significance of this disparity appears to be related to parthenogenesis which sometimes occurs in this group of insects, often accompanied by the production of a preponderance of females. Evidence on this question is conflicting, however, and the whole phenomenon is being investigated.

Whitefly Transmission Experiments.—(J. L. Gregory, G. S. Cotterell and Dr V. F. Eastop)—In the previous year, transmission experiments with individual plants were established in an attempt to determine whether *Bemisia* from one host species would oviposit and come to maturity upon another and so help to clarify the present confused state of the taxonomy of the *B. tabaci* complex. Some of these experiments gave positive results, but many did not, probably as a result of raising the plants in physiological or environmental conditions unsuitable for whitefly growth, or to using too few whiteflies for infestation.

Experiments were started in March 1957 to determine whether other host plants would become infested by repeated introduction of whitefly pupae from a particular host. The host plants used were cassava, cotton, sweet potato, tobacco, tomato, *Calapogonium* and *Euphorbia heterophylla*. A number of plants of each of the above species were placed in an insectary and about 50 pupae were added every other day, except for the experiments using pupae from tobacco where about 1,000 pupae were introduced at weekly intervals. The plants were inspected each week or fortnight, and notes were made on the populations that developed. The results given below show the time in weeks, before pupae were first noted on their new host plants :—

Source of Pupae	*Date Started*	*Cassava*	*Calapogonium*	*Sweet Potato*	*Cotton*	*Tomato*	*Euphorbia*	*Tobacco*
Cassava	1-3-47	2	6	8	2	2	2	20
Tobacco	24-7-57	1	13	8	3	4	5	1
Cotton	16-9-57	14	11	7	7	5	11	5
Sweet Potato	15-11-57	6	†	13	13	8	4	11

†No infestation had developed by 2nd May, 1958.

It seems likely that the seasonal suitability of any plant may influence the choice of host in the field as females showed no preference for the original host when laying eggs. Although the eggs hatched, no whiteflies reached maturity. It appears that there is a species of *Bemisia* in Nigeria that feeds upon a number of distantly related hosts but which transfers from one host species to another only under particular conditions.

THE BIOLOGY AND CONTROL OF YAM BEETLES (HETEROLIGUS SPP.)

(J. L. Gregory)

Beetle flights.—Counts of beetles attracted to a light source were made every night during the flight period at 9.00 p.m. at Lowlands Farm in Plateau Province. The first beetle was seen on 26th May and the last on 8th August, 1957.

A relationship was observed between the number of beetles found at the light source and the rainfall in the preceding two days. The average number of beetles counted in two days following rains of more than 0.5 inches was 42.3. The corresponding figure for days with rain less than 0.5 inches, or with no rain at all, was 11.6 beetles.

Breeding Areas.—The larvae of the most important of the Dynastid beetles attacking yams, *Heteroligus meles* Billb., have been recorded from only two areas in Nigeria, namely the flood plains of the Niger between Atani and Illushi, and at Ossissa in Delta Province near the River Ase. Many other breeding areas must occur, but if so they are very restricted and any study of the ecology of these areas may be of great value.

Yam beetle larvae were reported causing considerable damage to yams in the Asaba area in April 1956, and large numbers were also present in early 1957. The breeding area was therefore visited in February 1958 and was found to extend for at least six miles along the Asaba side of the River Niger to the south of the town and consisted of irregular undulations with ridges parallel to the river. Cultivation is usually carried out in the lower areas between the ridges where most silt is deposited during the annual floods of the River Niger.

The soil is characterised by a much higher content of clay and silt than is general in Nigerian soils, as would be expected from land that is almost entirely composed of alluvium deposited by the river Niger. Mechanical analysis showed a clay content for 12 samples averaging 26.5% (range 13.0 to 43.0%). Samples from pits which contained yam beetle larvae averaged 19.2% clay content (range 13.0 to 26.4%).

The number of larvae in the area was much smaller than in the previous year. One reason for this is that the river Niger, which floods the area every year, was slow in falling and uncovered the soil at a later date than in the year before. The height at which the Niger begins to inundate the larval breeding area at Asaba has been estimated at about the 21 feet mark on the marine tide gauge at Onitsha ; the river height fell to this mark on 14th November in 1957 and on 2nd December in 1958. The difference of 16 days may be important since at this time of year the adult beetles are looking for sites to lay their eggs and if the normal breeding areas are covered by water, eggs cannot be laid.

Natural biological control may also have reduced the numbers of yam beetle larvae. The Tachinid fly, *Microphthalma flavipes* Mesn., caused a considerable number of deaths among larvae from Asaba in 1957, although it is not possible to estimate the extent of the control thus exercised. In 1958 only two of the 251 larvae collected were parasitised by this fly. Both of the specimens collected on 20th February were in the second instar and contained almost mature parasite larvae.

Not only were the yam beetle larvae fewer than in 1957, but they were also less mature. In 1957, 89 per cent of larvae collected at Asaba on 23rd February were in the third (last) instar, whereas in 1958 only 28 per cent of larvae collected from Asaba were in the third instar on that date. This could be explained by delayed oviposition caused by the later recession of the floods.

Larvae Reared in the Laboratory.—The larvae collected at Asaba were used for life history studies. Observations in March showed that the larvae were not growing well, and trials were started to determine the optimum conditions for larval growth.

It was observed that larvae will feed well upon fresh yams, yellow yams being preferred to white. A number of foods were tried, and white yams, yellow yams and grass roots gave the best increases in larval weights. It was found important to maintain the moisture of the soil in which the larvae were living.

Field Control Experiments.—During the year, experiments were laid down to test the effect of various insecticidal dusts upon the yield of yams, and upon the amount of damage caused by yam beetle.

In previous years, a 0.45 per cent gamma BHC dust applied to the yam sett before planting increased the yield of yams in plots attacked by yam beetles and decreased the amount of damage caused by these pests. Several additional insecticides were obtained for comparison with BHC dust. Other methods of applying the dusts were also tried, namely, applying to the holes before planting and to the surface of the yam hill after planting. Ten experiments were laid down of which five, four and one were located in the Eastern, Western and Northern Regions of Nigeria respectively.

In several experiments, the attack rates were very low, and the insecticides did not have a sufficiently severe test ; yield increases and reduction in damage were accordingly low in these experiments.

Effect on Yield.—Yam setts treated with 0.45 per cent gamma BHC dust gave increases in yield over those in untreated plots averaging 7 per cent (range—20 per cent to +38 per cent). In experiments where the attack rate on untreated plots was over 20 per cent, the average yield increase caused by this insecticide was 11 per cent. A new formulation containing 0.5 per cent gamma BHC, which is to be marketed in Nigeria, gave an average increase of 16 per cent in yield.

The new insecticides used were 2.5 per cent Aldrin, 2.0 per cent Dieldrin, 1.0 per cent Endrin and 5 per cent Chlordane and they were applied as dusts to the yam setts before planting. In all experiments, they gave yield increases of 14, 8, 7 and 8 per cent respectively over the untreated plots. In experiments where over 20 per cent of yams in untreated plots were attacked, they increased yields by 26, 18, 16, and 20 per cent respectively. These dusts which have given promising indications are more expensive than the 0.45 per cent gamma BHC. Further investigations are required to determine whether their increased effectiveness may justify their use on economic grounds.

Reduction of Damage.—Plots treated with 0.45 per cent gamma BHC showed less damage than untreated plots by an average of 43 per cent. The 0.5 per cent gamma BHC reduced damage by 40 per cent. These results are to be expected from dusts so similar in content. The new insecticides, Aldrin, Dieldrin, Endrin and Chlordane reduced damage by 36, 49, 68 and 58 per cent respectively.

Thus the insecticides tried this year for the first time showed distinctly better results than the lower concentrations of BHC dusts, both in yield increase and control of yam beetle. Of the four, 2.5 per cent Aldrin and 5 per cent Chlordane appear to be the most promising. Endrin is effective but is too poisonous to man to be recommended for general usage. Dieldrin has not shown such good results as Aldrin except in one trial where the yams were planted in January in Rivers Province, and here it was much more effective than Aldrin. It is possible that Dieldrin, with its greater persistency, may be of use in areas where yams are normally planted very early.

Effect on Palatability.—The flavour of yams treated with the newer insecticides was again compared with that of untreated yams by Agricultural Assistants at the School of Agriculture, Ibadan. Eighty yams were sampled from plots treated with 2.5 per cent Aldrin, 2.0 per cent Dieldrin and 1.0 per cent Endrin, and 240 from untreated plots. Of these, four, seven, five and nine yams respectively were said to have a bad flavour. The insecticide treated yams did have a slightly higher proportion of bad flavoured yams but the differences were not statistically significant, and it seems unlikely that the insecticides were responsible for any deleterious effect upon the flavour of the yams.

CEREAL PESTS (K. M. Harris)

Research on the lepidopterous stem borers of maize, guineacorn and millet and on the sorghum midge of guineacorn was continued during the year.

Stem borers—Northern Region.—The objects of investigation in 1957-58 were to determine the economic importance of the main stem borer genera (*Busseola*, *Coniesta*, *Sesamia* and *Eldana*) on guineacorn, maize and millet ; to study the life histories of the most important species and to collect further information on the dry season carry-over of resting stage larvae in crop residues.

Work centred on the assessment of the actual loss of yield resulting from stem borer attack. Experiments were laid down at Kano, Samaru and Mokwa in which chemical control methods and a series of planting dates were used to produce different levels of stem borer attack which might be correlated with yield.

At Kano the regression coefficient of the yield of grain on the percentage stems bored at harvest was highly significant for the early millet experiment and demonstrated that in plots which had been attacked by *Coniesta ignefusalis* yields were significantly reduced. Stems which were not attacked by *Coniesta* yielded 701 lb of grain per acre—113 lb per acre more than the average for all stems which were attacked and 208 lb per acre more than stems which were severely attacked.

Experiments on late millet and guineacorn also at Kano, produced no statistically valid information.

At Samaru experiments on guineacorn were subject to great variations of soil fertility. There were no significant differences between any treatments but the late millet crop was a complete failure, the failure being largely due to a heavy attack of *Coniesta*.

Experiments on guineacorn and maize at Mokwa failed to produce significant results. The yields and levels of stem borer attack in these experiments are summarised in Table 5.

The results indicate that the methods used to control stem borer had little effect on the percentage of stems bored at harvest, despite the use of four applications of insecticide.

Chemical control methods were used in these experiments as an experimental tool and there is at present no indication of any economic return from the use of insecticides on guineacorn, but some evidence that, if efficient control measures can be devised, an economic return may result from their use on millet and maize.

Stem borer Biology.—Planting rains fell in April and local farmers planted early millet from April 3rd onwards. The main plantings of guineacorn were made towards the end of April.

Biological studies were continued at Samaru. Pupation of the dry season generation of *Busseola fusca*, which was present in crop residues, reached a peak between 13th and 19th May and adults emerged towards the end of May. By the end of June more than half of all the guineacorn grown in the villages of Bomo, Kurumi, Hayandogo, Samaru and on the Regional Research Station had been attacked by the first generation larvae and at the end of July samples showed that 80 per cent of all guineacorn stems in this area had been bored.

The emergence of adults of the dry season population of *Coniesta* also commenced in May and by early June more than 50 per cent of all millet stems from local villages contained larvae of the first generation.

The collections made during the growing season are summarised below :—

Summary of Random Samples of Stems collected from Villages in the Vicinity of Samaru, Zaria, during the 1957 Growing season

Crops	*No. of Stems collected*	*Stems bored per cent*	*Total number of living larvae and pupae found*			
			Busseola	*Coniesta*	*Sesamia*	*Eldana*
Guineacorn ..	3,900	80	1,390	324	31	36
Millet	1,900	62	166	2,668	26	5
Maize	1,500	19	81	3	36	10

The stem borer attack on maize is comparatively low but maize is of minor importance in this area. The attacks of *Busseola* on guineacorn and *Coniesta* on millet are of a very high order. There is every reason to believe that a similar level of stem borer attack prevails throughout most of Northern Nigeria. The dry season studies of stem borers at Samaru will not be completed until some time after the rains break in late April or early May. The results of dissections of crop residues up until 31st March, 1958 are given in Table 6.

These results confirm the observations made in the Annual Report for 1956-57 and give further evidence of the outstanding importance of crop residues in carrying over *Busseola* and *Coniesta* larvae from one growing season to the next.

Where compounds are built of guineacorn stems, and both guineacorn and millet stems are stored for use as firewood, thousands of stem borer larvae must be present at the beginning of the rainy season in even the smallest villages.

The destruction of these crop residues which play such an important part in village life over a large area of Nigeria is sociologically undesirable and it is hoped that further research will reveal methods which will destroy borers without it being necessary to destroy the stems which they inhabit during the dry season.

Stem-Borers—Ibadan.—An experiment on the late maize crop at Moor Plantation in 1957 showed that Endrin, applied as a spray at 6 oz active ingredient per acre, eight and fourteen days after planting, gave a good increase in yield which was probably due to stem borer control.

The most obvious effect of the insecticides used was on the loss of stand between thinning and harvest and on the number of stems per plot bearing cobs. The results are summarised in Table 7.

A comparison was made between the yielding capacity of severely bored stems and stems which were not severely bored : 500 severely bored stems produced 283 cobs yielding 42 lb dry grain, 500 stems not severely bored produced 435 cobs yielding 69 lb dry grain.

Experimental work on maize stem borers at Ibadan during the past six years has been reviewed and it has been concluded that stem borers reduce the yields of the second crop of maize appreciably and that, given an efficient and suitable method of control, increased economic returns can be obtained.

Sorghum Midge Survey.—A survey was designed to give an estimate of the overall loss of guineacorn resulting from the attack of sorghum midge, *Contarinia sorghicola* Coq., on native farms in Northern Nigeria.

Random samples of spikelets were collected in all provinces and were dispatched to the Regional Research Station, Samaru, where sub-samples of 50 spikelets were taken at random from each sample. Spikelets were dissected individually under the microscope.

The majority of the samples were taken at too early a date and contained a high proportion of spikelets which had not flowered. Since sorghum midge eggs are laid at or shortly after flowering the survey gave an underestimate of the severity of midge attack.

The connection between the level of midge attack and the percentage of non-flowered spikelets is shown below :—

RELATIONSHIP OF SEVERITY OF MIDGE ATTACK TO THE PERCENTAGE OF NON-FLOWERED SPIKELETS IN THE SUB-SAMPLES

Per cent spikelets containing midge larvae	*Per cent spikelets not flowered*
0	33
1-10	19
11-20	12
21-30	13
31-40	5
41-50	8
51-60	0
61-70	0
71-80	4
81-90, 91-100	No sub-samples in these categories

Sorghum Midge : biological studies.—At Samaru midges began to emerge from diapause in late June. Further development was similar to that described in the Annual Report for 1956-57 but, owing to the late continuation of the rains, the midge population reached a high level on guineacorn flowering in late October and early November. This has been reflected in the high population of diapausing larvae found in crop residues collected from local villages during the dry season.

The result of crop residue investigations are summarised below :—

INCIDENCE OF SORGHUM MIDGE IN SPIKELETS FROM GUINEACORN HEADS AND THRESHING TRASH COLLECTED FROM THE VILLAGES OF KURUMI, HANYANDOGO, BASO AND SAMARU DURING THE DRY SEASON 1957-58

	No. of spikelets dissected	*Infestation per cent midge*	*Infestation per cent larvae and pupae*
Guinea corn heads collected from fields, fences and stacks of stems	300	34	65
Spikelets collected from threshing trash	800	12	30

The spikelets in threshing trash are widely dispersed but during the sampling detailed above 3 lb of trash was found to contain 4,557 spikelets. It is difficult to estimate the quantity of trash disposed around the compounds of a village but the figures quoted above give some idea of the very high population of midge larvae which can be carried over from one growing season to the next in crop residues.

Midges have now been bred from the flower heads of the following grasses but in no case has any *Contarinia sorghicola* been found :—

Cynodon dactylon
Pennisetum pedicellatum
Pennisetum polystachyon
Eleusine indica
Eleusine sp.
Eragrostis turgida
Setaria pallidefusca
Panicum maximum

An assessment of the agricultural importance of sorghum midge must await the results of the 1958 survey.

INSECT RECORDS

Insect Pests.—The notorious sweet potato weevil, *Cylas formicarius* F., was intercepted by the Plant Quarantine Officer at Ibadan in slips of sweet potato planting material imported from Fiji. It has not previously been recorded from Nigeria although two other species of *Cylas* are known to occur locally.

Specimens of *Pinnaspis strachani* (Cooley) were collected by the Plant Quarantine Officer at Calabar from the Dunlop Rubber Plantation in the Southern Cameroons. It was reported to be extensively injuring young rubber saplings. This cosmopolitan scale insect attacks a wide range of crops. It is often recorded under the names of *Pinnaspis* (*Hemichionaspis*) *minor* (Mask).

Coffee at Moor Plantation was attacked during the dry season by the waxy scale insect *Ceroplastes personatus* Newst. It has been recorded from time to time in West Africa since 1898.

A leaf-mining beetle : *Coelaenomenodera elaeides* Maul, *Hispidae* was recovered from leaves of the oil palm, *Elaeis guineensis* Jacq. where it caused extensive damage at Moor Plantation.

ROUTINE COLLECTION OF APHIDS AND PSYLLIDS

(Dr V. F. Eastop)

The Entomology Section was responsible for the routine collection of aphids and psyllids from yellow Moericke trays located on Moor Plantation, Ibadan. This was a continuation of the work begun by Dr V. F. Eastop of the British Museum (Natural History) when he was stationed in Nigeria. Collections have been sent to Dr Eastop and identifications of specimens taken up to January 1958 have been received.

The cocoa psyllid, *Mesohomatoma tessmanii*, appears to be attracted to yellow trays in large numbers in the period of the early rains with peaks probably in March and April in 1956, and April in 1957. In both years there was a secondary peak, in August in 1956, and July in 1957.

The Iroko gall psyllid *Phytolyma lata* showed the largest numbers flying earlier than the cocoa psyllid in 1957. In the previous year, trapping started too late to catch more than the end of the population peak. More females were trapped than male, there being 501 females and 267 males taken. No similar tendency occurred with the cocoa psyllid.

There was a large flight of the Banana aphid, *Pentalonia nigronervosa*, in July 1956, but this was not repeated in 1957, save that numbers taken had increased rapidly from November 1957 to January 1958.

The citrus aphis, *Toxoptera citricidus* (vector of 'tristeza' disease of citrus) showed a peak flight during November 1956, which was followed by a subsidiary peak in June 1957 ; the population was again rising from November 1957 to January 1958.

A June flight of *Rhopalosiphum maidis*, the maize aphis, has also been a characteristic feature of the two years of observations at Ibadan.

Trapping of aphids in yellow trays was also done on the Federal Rice Research Station at Badeggi, beginning in the last four days of January 1957. The groundnut aphid, *Aphis craccivora*, was recorded in January 1957, and also in October, November and December, 1958. Seven specimens of the maize aphid, *Rhopalosiphum maidis*, were collected in June and one in December 1957. The rice root aphid, *Rhopalosiphum rufiabdominalis*, was taken in the trays in February, March, May and September to December. The population was highest in November and December.

Comparing catches from the two places, the most striking difference lies in the number of specimens taken. From February to December 1957, 116 aphids of five species were taken at Badeggi while in July 1957 alone 138 specimens of one species were taken at Ibadan. This difference may, however, be due to the siting of the traps.

The maize aphis flew at the same time of the year, namely June, in both localities.

PLANT PATHOLOGY

STAFF

Dr S. R. Chant	*Plant Pathologist*
S. G. Jackson	*Technical Officer*
J. A. Marden	*Technical Officer*
E. D. Oddy	*Technical Officer*
J. K. Olurin	*Technical Officer*

Investigations during the period under review included cassava mosaic, a suspected virus disease of yams, cow-pea mosaic virus and pepper viruses. The Plant Pathologist was also in charge of the Federal Plant Quarantine Service.

CASSAVA MOSAIC

Studies on the Physiology of Virus-infected Cassava : Net Assimilation Rate (NAR).—A field experiment carried out from June to November 1957 on a Samaru hybrid, B9, showed that the leaves of mosaic-infected plants produced less total fresh weight and dry weight than those of healthy plants at each of five sampling dates made at monthly intervals from the time of planting. Infection with cassava mosaic virus also resulted in a decrease in leaf area in each sample and although the NAR was consistently less for infected samples the differences did not reach significant levels.

Effect of Shade on Cassava Mosaic Virus. -An experiment carried out in shaded and unshaded chambers of an insect-proof screenhouse with variety B9 revealed decreases in fresh and dry weight of leaves, stems and petioles of infected plants when compared with healthy plants in normal light intensity. Where the light intensity was reduced to one third of the normal only the fresh weight and the dry weight of the petioles was affected. Only 19.5 per cent of the total leaf area of the infected plants growing under shade was found to be chlorotic in contrast to the condition of infected plants grown under normal light intensity, where 35.6 per cent of the total leaf area showed symptoms.

Anatomical studies on leaves of plants infected with cassava mosaic virus have shown that in sections of the chlorotic areas there is complete lack of differentiation of palisade tissue, and in some leaves normal palisade tissue is only to be found at the midrib. The cells are polyhedral in shape and contain chloroplasts which are irregular in shape and fail to give an intense reaction to staining with iodine solution.

Although the xylem of the midribs and laminae appears to be little affected, the phloem elements of the midrib are restricted to small bundles of cells in contrast to the more regular radially arranged elements of healthy leaves. There is no sign of any blockage of the phloem sieve tubes in the leaves or stems of plants infected with cassava mosaic virus and apart from the occurrence of starch grains in the pith of the midrib of healthy leaves there are no other obvious differences in the anatomy of healthy and virus-infected leaves.

The effect of Infection by Cassava Mosaic Virus on the Diurnal Fluctuation of Total Carbohydrate and Total Nitrogen Content of Cassava Leaves.—Preliminary studies undertaken in collaboration with the Plant Breeder have shown that the diurnal fluctuation of total carbohydrate in leaves from mosaic-infected cassava plants is much less than that in comparable leaves from healthy cassava plants. From the data so far obtained it appears that infection with cassava mosaic virus results in an increased total nitrogen content of the leaf.

Studies in Heat Therapy.—Cassava mosaic virus has been successfully inactivated by heat treatment of the growing cutting. Temperatures of 37°C and 39°C are sufficient to inactivate the virus if the cuttings are kept at these temperatures for 4 to 6 weeks. A greater measure of control has been achieved by excising the young green shoots from the parent cutting immediately after heat treatment and rooting them separately. These later gave healthy plants although some of the parent plants subsequently developed symptoms in the screenhouse.

Transmission Experiments.—Experimental work on aspects of the transmission of cassava mosaic virus by white-flies (*Bemisia* spp.) has been continued and will be published elsewhere.

A field experiment was laid down at the beginning of July with the objects of assessing the effect of age of seedling on its susceptibility to virus infection and of studying the rate of infection in relation to the rate of build-up of the whitefly population.

The results, so far, indicate that the lowest incidence of infection occurs in the oldest age-group of seedlings but that the number of adult whiteflies and larvae on the seedlings does not differ significantly between age groups.

An attempt has been made to correlate rainfall (*i.e.*, number of rainy days as well as amount of rain) with fluctuations in whitefly population but Golding's observation (1936) that heavy showers reduce populations owing to the mechanical action of the rain killing the whiteflies has not been confirmed. Counts made after the two periods of highest rainfall over the duration of the experiment 9th-16th September and 23rd-30th September were higher or as high as counts made after the preceding or in the succeeding weeks when the rainfall had been much less.

SUSPECTED VIRUS DISEASE OF YAMS

All attempts at transmitting the suspected virus by grafts have failed. It has not been possible to produce a satisfactory graft union between the stems of infected and healthy plants. The quick inoculation technique which has been found to give successful results in Costa Rica with a local virus disease of yam has not produced results with the Nigerian yam disease.

A collection has been made to provide material for the yam Virologist to work with on his arrival in 1958.

COWPEA MOSAIC VIRUS

This virus, of which one strain at least is known to be a form of tobacco mosaic virus (Lister and Thresh, 1955), was found widespread on cowpea throughout the Western Region in September 1957. Preliminary observations suggest that introduced varieties (*e.g.*, New Era, Dr Saunders' Upright etc.) are much more severely affected by the virus infection than the local varieties and that there is more than one strain of the virus.

Virus from cowpea has been successfully transmitted to French bean but so far no other alternate host has been found. *Datura* sp., sweet and chilli pepper (*Capsicum* sp.) and tomato do not appear susceptible. Preliminary investigations have also been made into the possibilities of finding an insect vector of the virus.

OTHER DISEASES

Other diseases reported during the year included a brown rot of tobacco caused by *Phytophthora parasitica*, a leaf disease of water yams associated with *Glomerella cingulata* and a virus disease of sweet potato and *Ipomoea* sp. A coffee disease at Santa, Southern Cameroons was investigated in July 1957. The appearance of the symptoms was suggestive of Elgon die-back (Hot and Cold Disease) caused through lack of sufficient shade.

PLANT QUARANTINE

In addition to the maintenance of routine work at the primary Plant Quarantine Station at Moor Plantation, Ibadan, a start was made in the establishment of secondary Plant Quarantine Stations at Calabar and at Kano. A total of 93 Plant Importation Certificates and 97 Phytosanitary Certificates were issued.

Plants held in quarantine included rubber from Malaya, sugar cane from India, bamboo from Singapore, cocoa plants from Ghana and Kew (Lafi No. 7) and *Ipomoea*, *Colocasia* and *Xanthosoma* spp. from Fiji.

Dangerous pests intercepted included mealy-bug vectors of cocoa swollen shoot virus on cocoa imported from Ghana, and the sweet potato weevil *Cylas formicarius* on *Ipomoea* from Fiji. The imported material was effectively destroyed under supervision of a Plant Quarantine Officer.

WEST AFRICAN MAIZE RESEARCH UNIT
C.D. AND W. RESEARCH SCHEME R471

STAFF

Dr R. H. Cammack .. .. *Mycologist*
C. L. M. Van Eijnatten .. .. *Plant Breeder*

The following is a summary of the work of the West African Maize Research Unit during the current year. Detailed accounts are given in the Unit's Annual Report.

Breeding.—The selection of existing varieties has reached the stage where attention is being directed towards the environmental suitability of these selections in the various climatic zones of West Africa. A collection of 130 Caribbean varieties was tested in the rain forest areas of Nigeria and Ghana during the year and a group of varieties from Martinique has proved very promising in this environment. The evaluation of the Mexican group is nearly completed and a programme of varietal selection and improvement has commenced.

A series of 29 trials was laid down throughout Nigeria and the Cameroons in order to determine the response of current selections to environment. Various varieties, differing in maturity time and seed type, were incorporated in these trials and the results will give information on the interaction of such factors as variety, locality and disease incidence.

The basic breeding work has been the production of inbred lines on the basis of individual plant selection. Recurrent selection cycles were started with the first inbred stages and their general combining ability is being tested by crossing out to parental varieties. Inbreeding is continuing with the ultimate aim of obtaining synthetic varieties derived from a number of inbreds of good combining ability, in order to prevent a disadvantageous narrowing of the gene populations within varieties.

A trial has been carried out with lines derived from the Minnesota group, carrying resistance to the European corn borer. A comparison was made of highly susceptible West African varieties, susceptible but high yielding Mexican x Minnesota crosses and the first and second back-crosses to the Mexican varieties.

Pathology.—A new virus disease of maize, provisionally termed pellucid ring spot, is now widespread and must be considered a major maize pathogen. Caribbean varieties, possessing resistance to *Puccinia polysora*, were severely attacked during 1957, and to a lesser extent several West African locals. On the basis of field observations an aphid vector is suspected. All attempts to transmit the disease mechanically have failed.

Investigations on the use of combined fungicide-insecticide seed dressings have been completed. Trials were carried out in Northern and Southern Nigeria to study the effects of different levels of application of dressings in relation to yield, time of planting, variety and grain character. No significant differences were obtained between treatments. Suppression of germination was observed with certain levels of application of BHC.

An analysis of measurements of uredospores of *P. polysora* was made with the co-operation of the Commonwealth Mycological Institute and the Arthur Herbarium. Measurements from samples of uredospores from all existing world collections showed a highly significant difference between the dimensions of spores from the African Continent and those from South East Asia and adjacent islands. The results suggest that distinct and geographically isolated forms of *P. polysora* exist.

Studies on the life cycle of *P. polysora* have been concluded. Repeated attempts have failed to induce germination in the teleutospore and the aecidial and pycnidial host is unknown. Until such time as further evidence becomes available the rust should be considered to be an autoecious hemi-form.

Quantitative studies on the incidence of *P. polysora* have continued. The analysis of several years' records of the uredospore content of the atmosphere, obtained by an automatic volumetric spore trap, has shown that the time of outbreak of the rust can be forecast each year. Onset of rust in the field can be expected when the atmospheric uredospore content rises above 5cu. m. This value has been termed the 'primary epidemic threshold'.

PUBLICATIONS

B. D. A. Beck and S. R. Chant
1958. Preliminary studies of cassava mosaic virus on *Manihot utilissima* Pohl. in Nigeria.
Trop. Agriculture, Trin. **36** (1) : 59-64.

R. H. Cammack
1957. A new virus affecting maize
Commonw. Phytopath. News **3** (4) : 61-62.

R. H. Cammack
1958. Studies on *Puccinia polysora* Underw.—I
The world distribution of forms of *Puccinia polysora*
Trans. Brit. mycol. Soc. **41** (1) : 89-94.

S. R. Chant
1957. Die-back of cocoa seedlings in Nigeria caused by a species of *Phytophthora*.
Nature Lond. **180** : 194-195.

APPENDICES

TABLE 1.—SHOWING RATE OF RECRUITMENT OF SPECIALIST STAFF IN THE FEDERAL DEPARTMENT OF AGRICULTURAL RESEARCH AS AT MARCH 1952-1958. (INCLUDING 3 POSTS IN THE WEST AFRICAN MAIZE RESEARCH UNIT)

Specialist Establishment	1952	1953	1954	1955	1956	1957	1958	*Total for 7 years*
Authorised	19	19	19	20*	20*	26*	46	—
Actual..	9	11	11	13	15	14	15	—
No. recruits	—	2	1	4	3	3	3†	16
No. retirements or transfers	—	—	1	2	1	4	2	10

* Excludes Fungicides Research Scheme now abandoned.
† 1 Temporary Post.

TABLE 2.—METEOROLOGICAL DATA FOR MOOR PLANTATION, IBADAN, 1957

Month	*Rainfall*				*Mean RH%* 0900 *GMT*	*Mean Temperature at* 0900 *GMT*		
	Inches	(*Days*)	*Cumulative Total* (*inches*)	*Previous Average* 1948-57 (*inches*)		*Max °F*	*Min °F*	*Mean °F*
January ..	—	—	—	0.37	65.1	91.8	63.4	77.6
February ..	—	—	—	1.05	65.3	96.7	65.2	81.0
March ..	7.06	(11)	7.06	3.25	76.5	94.4	68.0	81.1
April ..	6.34	(13)	13.40	5.89	81.2	91.5	68.5	80.0
May ..	8.67	(16)	22.07	5.90	82.3	90.3	67.9	79.1
June ..	4.31	(14)	26.38	6.90	81.8	88.4	67.9	78.2
July.. ..	6.88	(24)	33.26	5.49	85.7	84.6	68.1	76.4
August ..	4.87	(20)	38.13	3.18	87.5	83.0	67.4	75.2
September ..	10.25	(16)	48.38	7.94	86.9	85.5	67.7	76.6
October ..	7.54	(20)	55.92	7.28	85.5	87.1	67.2	77.2
November ..	3.78	(8)	59.70	2.01	84.0	89.9	67.3	78.6
December ..	0.99	(2)	60.69	0.30	86.6	89.8	66.4	78.1
Total ..	60.69	(144)	—	50.57	—	—	—	—
Mean ..	—	—	—	—	80.7	89.5	67.1	78.3

TABLE 3.—RECORDS OF EVAPORATION FROM A FREE WATER SURFACE AT MOOR PLANTATION IBADAN, 1954-1957

Month	Evaporation (inches)			
	1954	1955	1956	1957
January	3.39	3.13	3.65	4.00
February	3.97	4.08	4.08	4.67
March	5.92	4.42	4.86	7.10
April	4.82	4.65	4.76	5.00
May	4.17	4.72	4.24	6.53
June	3.63	4.42	3.84	3.72
July	2.91	3.08	3.20	3.04
August	1.96	2.46	2.15	3.19
September	2.97	2.81	2.86	5.13
October	4.06	5.65	4.12	3.34
November	5.12	4.03	3.73	3.49
December	3.85	3.55	3.81	3.53
Total	46.77	47.00	45.30	52.74
Mean	3.90	3.92	3.77	4.40

TABLE 4 —METEOROLOGICAL DATA FOR THE RICE RESEARCH STATION, BADEGGI, 1957

Month	*Rainfall (inches) Badeggi*	*Average Rainfall Bida 28 Years*	*Relative Humidity at 0900 GMT*	*Maximum Temp. °F*	*Minimum Temp. °F*	*Mean °F*
January	0	0.12	51.5	92.7	62.9	77.8
February	0	0.32	41.7	96.7	60.5	78.6
March	0	1.04	57.7	98.7	71.0	84.9
April	1.56	3.04	67.0	97.6	76.3	87.0
May	8.16	6.01	79.0	97.7	74.1	85.9
June	7.46	7.41	80.2	89.1	73.8	81.5
July	17.31	8.12	87.2	86.9	73.7	80.3
August	8.60	8.54	83.9	86.2	75.0	80.6
September	6.94	10.08	84.0	87.3	73.1	80.2
October	6.67	4.32	79.4	89.0	75.5	82.3
November	0.70	0.31	74.33	92.1	72.7	82.4
December	0	0.01	64.5	92.9	60.6	76.8
Total	56.52	46.32	—	—	—	—

TABLE 5.—YIELDS AND LEVELS OF STEM BORER ATTACK IN 9 EXPERIMENTS CONDUCTED IN N. NIGERIA 1957-1958

Locality	*Crop*	*Plots treated with insecticide to control stem-borer*		*Plot not treated with insecticide*	
		Yield, lb. grain/acre	*Per cent stems bored at harvest*	*Yield, lb. grain/acre*	*Per cent stems bored at harvest*
Kano	Guineacorn	1,435	13	1,326	15
	Early Millet	612	60	648	61
	Late Millet	431	18	416	26
Samaru	Guineacorn	312	74	240	71
	Early Millet	74	58	61	70
	Late Millet	—	97	—	99
	Maize	767	18	680	24
Mokwa	Guineacorn	522	92	598	86
	Maize	744	67	616	86

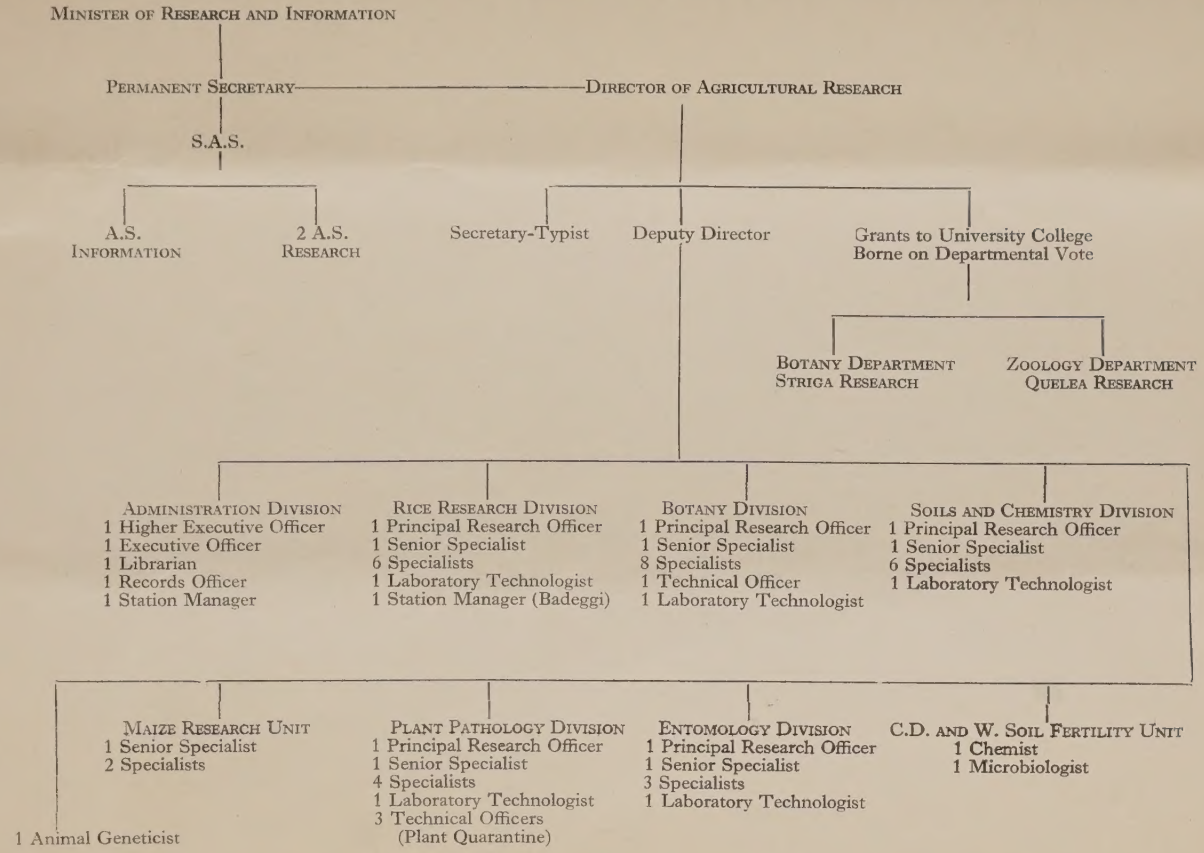
TABLE 6.—SUMMARY OF INCIDENCE OF STEM BORERS IN CROP RESIDUES COLLECTED FROM VILLAGES NEAR SAMARU DURING THE DRY SEASON 1957-58

	Number dissected	*Number of live stem borer larvae and pupae per 100 stems/stubbles*			
		Busseola	*Coniesta*	*Sesamia*	*Eldana*
Millet					
(*a*) Stubbles in fields	3,000	less than 1	12	less than 1	less than 1
(*b*) Stems lying in furrows ..	400	—	57	—	—
(*c*) Stems kept in stacks in field or compound	400	less than 1	48	—	—
Guineacorn					
(*a*) Stubbles in fields	3,600	1	1	less than 1	less than 1
(*b*) Tillers growing during the dry season	700	—	—	25	—
(*c*) Stems lying in furrows ..	500	8	less than 1	less than 1	less than 1
(*d*) Stems kept in stacks in field or compound	1,200	16	2	less than 1	less than 1
Maize					
(*a*) Stems lying in furrows ..	600	—	—	—	less than 1

TABLE 7.—SUMMARY OF ANALYSIS: LATE MAIZE CROP: STEM BORER CONTROL, FIELD Z. 2 MOOR PLANTATION, 1957-58

Treatment	*Yield lb. lb. grain/ acre*	*Per cent loss of stand between thinning and harvest*	*Per cent stems severely bored at harvest*	*No. of stems per plot bearing good cobs*
Endrin Spray 6 oz. active ingredient/ acre	1,007	6	19	339
Dieldrin dust 6 oz. active ingredient/ acre	919	10	35	285
Heptachlor spray 6 oz. active ingredient/acre	842	12	32	263
Malathion spray 10 oz/acre	814	17	31	249
Control	747	22	31	250
DDT dust 16 oz./acre..	736	21	34	219
5 per cent significant difference ..	± 179	±5.2	± 7.7	±51
1 per cent significant difference ..	± 240	±7.1	±10.5	±69
0.1 per cent significant difference ..		±9.5	±14.0	±92

ORGANISATION OF THE FEDERAL DEPARTMENT OF AGRICULTURAL RESEARCH AS AT 31ST MARCH, 1958



2–3–59
6–5–59
11–5–59
9–6–59

691/559/1,500(148